HEALTH
MORALS AND LONGEVITY

BY

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REGIUS PROFESSOR OF MEDICINE IN THE

UNIVERSITY OF OXFORD,

IN APPRECIATION OF HIS VALUABLE

AND INDEFATIGABLE WORK,

AND IN ADMIRATION OF

HIS GENIUS.

PREFACE.

In presenting this work the authors would firstly mention that it purports to be a short résumé of the more important conditions of living a healthy life. These requisites are considered from the twofold aspect, viz., (*a*) That of individuals, and (*b*) That of aggregations of these, or communities. So far as the former are concerned—and they are concerned in both ways—most people would obviously desire to be, or to become, and remain, vigorous, if only they could gain the knowledge of how to ensure that object. Yet many there are who, from ignorance of what actions should be done and what avoided, i.e., owing to errors of omission and of commission alike, pass much of their existence in an enfeebled and weak, or at least a not vigorous, state. Moreover, the measures needful for health are not exclusively in their own hands, and under their own control, for each human being—especially nowadays—is greatly affected both by the conditions and the actions of other people living in the neighbourhood.

The chief difficulties which stand in the way of preserving the health certainly spring from the dense aggregations of human beings, whence grave dangers arise. The air of country districts is, as a rule, far purer and more exhilarating than that of towns, and yet people congregate together in such large numbers in the latter as to be continually injurious to one another—in many cases, no doubt, being, to some extent, practically obliged to thus reside in close proximity to others, in order to gain the means of subsistence. The mortality of the plague in Great Britain in six months in 1665 seems to have been about 100,000, and it is possible that some of the old empires were destroyed by terrible diseases devastating large cities and tracts of country. The fact that there are not often such immense losses from epidemics in the more advanced nations shows how sanitary science has enabled man to cope with the dangerous factors of disease.

If our hygienists were ignorant and incompetent, one can only shudder to even dimly imagine the terrible decimation which might befall the people of England and Wales, and the small adjacent islands (not to speak of other countries for the present), who on April 1st, 1901, were 32,678,213 in number. Taking a square yard for each, 4840 might stand upon the 4840 square yards in an acre. A square mile (640 acres) would accommodate 3,097,600, and 32,000,000 persons would thus obviously require more than ten square miles. A column, four abreast, would extend

3778 miles, and would take four-and-a-half months to go past a spot at quick march. (*Abstract of Census.*)

We are indeed, in England and Wales, somewhat densely congregated, and the same is also the case in Germany, and indeed nearly all highly civilized countries.

To show how long-lived mankind is now becoming, it may be noted that at the date of the last census, as we read in the valuable report of the same, there were in England and Wales 177,267 of eighty years or more. It may also be said that the "probable lifetime" at birth of a male in England and Wales is about forty-four, and of a female forty-seven, years. By that time a given number of human beings born are reduced by one-half, and hence the chances of attaining or not that age are just equal. This is not the same, of course, as the average expectancy at birth, which is deduced from the numbers who survive at all successive ages out of a given number born. This has been estimated to be at birth 40·9.

Many complex problems have been very much simplified, and some, almost solved, we may hope will soon be more completely still comprehended, and the best clues to them found. Nevertheless, in spite of all that has been, and is being, accomplished, it remains true that much of the ill-health and lack of energy of the present age is inseparably connected with the density of the population in towns and cities. In order to overcome the infectiousness which abounds on all sides, the system gets into a habit, so to speak, of protecting itself against germs and their toxic products, by manufacturing, as occasion requires, anti-toxins, and these in themselves may perhaps for a time at least produce a low state. Flowers will not grow so well in the gardens of towns as in the fresher air of country surroundings, and it is just the same with animals, and still more so in the case of human beings. A seaman enjoys a robust state of vitality on board a ship as a rule, and seldom takes cold; but he is very liable to do so when he comes to live in a town, especially if not wary as to infection. Indeed he will be more likely than a landsman to fall a prey to any disease, unless he be very cautious and careful, because the latter has become accustomed to the risks, which his body has acquired the means of combating. This is also the reason why extra care is necessary after a holiday at the seaside or in the country—whereby the system has, so to speak, become off its guard—so as to be able at once to react successfully against the sudden increase of danger.

Some technical questions bearing on the subject of health are herein briefly mentioned, but for the most part the more complex points are discussed in the Appendix. Moreover, by the general reader such portions as may be found too abstruse may be omitted, those topics being selected which are most apposite to the purpose in view.

The book is put forth merely as a sketch of the important subject

dealt with—healthy and vigorous life—how best to ensure and maintain it, a mysterious problem bristling at every point with well-nigh baffling questions. In regard to these, we have tried to give what may be said on various sides, to throw some additional light, and present some fresh points of view. Originality is not, of course, always possible in regard to topics which have been so much discussed, and several observations of renowned savants, hereafter and in the pages themselves referred to by name, have been incorporated here and there. Yet there are also many statements and opinions for which the authors are directly and entirely responsible.

However, when we consider that our present degree of civilization and culture is in some respects not much higher than that of many ancient peoples, and that we have lost touch with artistic and scientific knowledge of the dim past, much of which we have no doubt slowly re-acquired, it is obvious that practically "there is nothing new under the sun." Two recent striking examples of this which have come to our notice are: (1) the fact that, according to Dr. Harry Campbell, some very low tribes employ a kind of vapour bath, and also a sand bath; and (2) the fact recorded by Mr. James Cantlie that the Chinese developed the science of medicine 2000 years before Christ, a good work on the pulse having been produced by this intellectual people 600 B.C. Also a surgeon's abdominal operation conducted antiseptically is recorded. Pupils were taught by a system of apprenticeship. When we consider that some of our so-called new methods were practised by this ancient race some 3000 years and more ago, it makes us wonder.

In regard to the very difficult questions connected with the milk-supply, it is probable we may all be agreed that every effort should be made to render it a clean and pure one; even though it be considered doubtful if human beings are capable of becoming affected with human tuberculosis from the milk or flesh of the ox. This is a point perhaps not yet conclusively settled; but there can be no doubt whatever that milk is very frequently a medium of severe illnesses other than tubercular, and of death arising therefrom. Infant mortality is probably largely dependent upon the imperfections of the milk-supply. It seems unfortunate that the late Dr. D. A. Gresswell's Milk Bill for Australia was not carried into operation, owing to his unexpected death.

Reference has been made to several works, including those of Prof. Elie Metchnikoff on *The Nature of Man*, *The Prolongation of Life, and Immunity*—*Green's Encyclopædia of Medicine and Surgery*, treatises on *Hygiene*, by Dr. Stevenson and Sir Shirley Murphy, also by Drs. Louis Parkes and Henry Kenwood, by Dr. Frith, by Dr. Gardiner, by Dr. W. H. Hamer, *Dauer des Lebens*, and Sir E. Ray Lankester's *Comparative Longevity*. Several authors of works and papers in the various journals have also been consulted, including Sir T. Lauder Brunton, Sir Hermann Weber, Sir F. Treves, and

Drs. Wm. R. Huggard, A. T. Schofield, August Weismann, A. Wiedemann, H. Coupin and J. Lea, Ehrlich, N. E. Davies, F. T. Paul, I. Burney Yeo, Michael Haberlandt, Rev. J. G. Wood, Basil Tozer, and Dr. D. Astley Gresswell (brother of the authors), recently President of the Board of Health of Victoria, Australia, some of whose valuable work, generally acknowledged, has been utilized in the book. Several other points have been gained from the following valuable periodicals, from which the authors have borrowed certain information—sometimes, but not perhaps in every case, acknowledged in the text: *The Nineteenth Century; The Hospital; Wide World Magazine; The Lancet; The Times; Daily Chronicle; Daily Mail; Morning Leader; Daily News; Daily Express; Golden Penny; Country Life.* Other sources of information and writers alluded to are generally mentioned in the book; but if inadvertently in any instance we may have omitted this duty, we herewith apologize. Also we beg to mention that helpful criticisms and suggestions will be acceptable, as it is our hope and intention to keep the work up to date in accordance with advancing science, and we wish to correct all faults and supply shortcomings, in order to maintain its value for those who do us the honour of study or of perusal. We may also say that some of the gist of three lectures delivered by G. Gresswell, viz., before the Grimsby Literary Society, the Grimsby St. James' Church Mutual Improvement Society, the Grimsby Co-operative Women's Society, as well as of articles previously published, is incorporated in this work. Finally, we submit this book, not without hope, to the favourable consideration of the public and the press, in the belief that it is perhaps the most important that has yet issued from our pen.

KELSEY HOUSE, MERCER ROW,
LOUTH, LINCOLNSHIRE.

February, 1909.

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THE MEANING OF SYMBOLS USED IN THIS BOOK.

I.—Non-metals.

Hydrogen	H
Chlorine	Cl
Bromine	Br
Iodine	I
Oxygen	O
Sulphur	S
Nitrogen	N
Phosphorus	P
Arsenic	As
Carbon	C
Silicon	Si

II.—Metals.

Potassium	K
Sodium	Na
Calcium	Ca
Barium	Ba
Magnesium	Mg
Zinc	Zn
Lead	Pb
Copper	Cu
Silver	Ag
Mercury	Hg
Aluminium	Al
Manganese	Mn

Metals—*Continued.*

Iron	Fe
Tin	Sn
Vanadium	V
Antimony	Sb
Bismuth	Bi
Gold	Au
Platinum	Pt

Compounds.

Water	H_2O
Carbon Monoxide	CO
Carbon Dioxide or Carbonic Acid Gas	CO_2
Sulphuretted Hydrogen	H_2S
Marsh Gas	CH_4
Nitric Acid	HNO_3
Sulphuric Acid	H_2SO_4
Hydrochloric Acid	HCl
Carbonate of Sodium	Na_2CO_3
Carbonate of Calcium (Chalk)	$CaCO_3$
Sulphate of Calcium (Gypsum)	$CaSO_4$
Chloride of Barium	$BaCl_2$
Sulphate of Barium	$BaSO_4$
Sulphate of Magnesium (Epsom Salts)	$MgSO_4$
Manganese Dioxide	MnO_2

"They are as sick that surfeit with too much, as they that starve with nothing: it is no mean Happiness, therefore, to be seated in the mean. Superfluity comes sooner by white hairs, but Competency lives longer."

Shakespeare.

"By Nature honest, by Experience wise,
Healthy by Temp'rance and by Exercise,
His Life, though long, to sickness pass'd unknown,
His Death was instant, and without a groan.
O grant me thus to live, and thus to die!
Who, sprung from kings, shall know less joy than I?"

Pope.

"The ingredients of health and long life are:
Great temperance, open air,
Easy labour, little care."

Sir Philip Sidney.

HEALTH,

MORALS, AND LONGEVITY.

CHAPTER I.

INTRODUCTORY.

THERE are times when the fact of life appears to the mind as a weird and momentous problem which cannot be lightly set aside. The mystery of our conscious existence, and the momentous reality of our bodies whilst remaining alive on the earth, recur to our minds with vehemence and persistency, and claim earnest consideration.

Then it is that we may in some degree realize those deep, unerring, and eternal truths underlying life which the greatest men in many ages of the world, after much philosophic thought and consideration of that mysterious fact of vitality, perhaps in most cases spiritually enlightened to discover them, realized. Then it is that we look upon life as a wondrous blessing with which we have been endowed, in order that we may unceasingly strive with firm resolve to do our best for human beings upon the wide earth. We ought to be always vigilant to direct our actions wisely, and leave no stone unturned to preserve health, so that our bodily and mental powers may retain their full vigour. It is indubitable that the continuance of one's healthy life in great measure depends upon the wisdom and strength of the exertions put forth by each individual with that end in view. Unceasing care is requisite for the attainment of long life ; but the reward of feeling well repays for the constant trouble.

Now it is by no means unusual to find that persons who have lived to a good old age have been feeble and weakly-looking as children, and even sometimes delicate up to and beyond the adult stage. By the exercise of constant judgment, and only by that, can even strong persons work patiently on from year to year with equanimity and with vigour. In their case the strength may not only not diminish, but even increase, as time rolls on.

Delicacy of constitution, then, even extending beyond middle age, does not preclude the chance of longevity. Probably, when feeble children live for a long period, as is not at all unusual, it is by persistent watchfulness that they have been enabled to do so, and if such cases occur, how much more might the strong expect to retain the valuable gift of vitality. Unquestionably, healthy life is pleasurable.

Human beings differ very much in regard to "staying power," and, strange to say, those who are endowed with excellent health and strength may succumb to illnesses or other difficulties, such as anxiety, grief, and sorrow, which apparently weaker persons may be able to surmount successfully. Even putting aside the severe attacks of diseases and injuries occasioned by accidental and other causes, extreme privation, excessive anxieties, and the like, we still do not by any means always find that those who look strongest and healthiest live the longest. On the contrary, they frequently die quite suddenly, and apparently from small causes at times. There are in fact other factors, such, for example, as "will to live," "carefulness," "endurance," "knowledge," and "wise discrimination." We may, therefore, hope to gain long life by well-directed efforts, unremitting self-mastery, and abnegation of seeming pleasures, such as indulgence in wines and tobacco, or other kinds of excess. The strong and active should exercise self-control, no less than the weak, for their very strength may otherwise lead them into dangerous courses, which sooner or later are bound to be disastrous. The weakly need not abandon the hope of a long continuance of life, nor give up the struggle in despair, if only they never cease striving to fulfil the various conditions which are essential for health. There are, in fact, certain indispensable rules which must be observed by those who wish to live long and wisely and well. Only by so regulating conduct, can they carry out successfully the great work of aiding the progress of humanity, wherefrom the only true and lasting happiness can be derived. As each person's years pass away, joyful aspirations may aid in sustaining one's efforts to do better in the coming time than in the past. We may remember that much human joy swiftly speeds away, and that errors and shortcomings bring great difficulties in their train. Yet few realize the significance of existence, and the responsibilities it entails. Many are apt to infer that our actions only affect ourselves, and that, in so far as we fail in our duty, we only injure ourselves. This is obviously not the case, our actions necessarily affecting the surroundings, and especially our fellow-creatures, in their results. The future may be regarded with hope, if men strive to render the world better, and even if the power to do so falls far short of their highest wishes and best endeavours.

The object of the following pages is to indicate how to preserve in health the bodies wherein our souls are temporarily, and doubtless for some good though inscrutable purpose, encased. Many people are, in such matters as relate to, and determine degrees of, health, very wanting in knowledge, and consequently live at a low ebb of energy for the greater part of their time on earth. Thus the work they do cannot be of very great value. How to live as long and as well and wisely as possible is indeed a difficult problem; but still it is one capable of being solved in several respects with much precision. The state of health depends in great measure upon factors of which many are fairly well-known, and others, though as yet not clear, are capable of being ascertained by skilful research.

Very many abuses, sources of disease and death, have been resolutely dealt with, though still there remains much to be done. The people are better cared for by the State, albeit that in various respects it is just possible to doubt if the legislative action has been entirely right. Many of the modern measures of sanitation are doubtless the outcome of the growing intelligence of civilized peoples, who, in matters affecting health, are wiser, more alert, and more temperate than of yore.

That very much has been effected in the way of sanitation and the prevention of disease is proved by the very important fact that the annual death-rate of the City of London, which in the latter half of the 17th century was as much as 80 per 1000 of the population, and in the 18th century sank to 50 per 1000, is now only about 16 per 1000. We ought not to be satisfied with a higher rate of mortality than 15 per 1000 in any urban or rural district, as any excess over that proportion is doubtless capable of being removed by strict carrying out of hygienic principles.

A distinction may be made between those measures which are directed to secure the public health, and those which concern the life of each individual person. Although these are generally in correspondence, they may not always be so, for the well-being of the aggregate may entail in some cases discomfort, and even danger to some.

The sanitary officials protect the public against defects in water-supply and the disposal of sewage and other waste-matters, and against contact with exotic infectious diseases by quarantine. They secure isolation of persons affected with certain maladies, destruction of virus by cleansing and disinfection, regulation of dangerous occupations, and inspection of food.

Such matters are carried out by the State ; but, in addition, each individual should see to cleanliness of self and surroundings, select good diet and clothing, take sufficient exercise in the fresh air, and an adequate amount of rest.

Care of the body is the first requisite for health, and this resolves itself mainly into questions of internal and external cleanliness.

Strength and force of will and determined fixity of purpose to reach a desirable goal depend on one main condition, the well-being of the body. Vigour of mind is usually associated with health. Unless one be in good health, the achievement of any great work is almost out of the question, and faults and deficiencies may often result from derangement of bodily and mental functions.

In order to preserve life, many precautions are necessary, for example, such as relate to food, clothing, shelter, and the relations of the sexes. Wise selection of edibles and control of the reproductive system are especially requisite.

Great advances have been made in our knowledge of the measures which conduce to healthy life, and hence we may feel encouraged to persevere in resisting the grim monster Death, who is not far distant from any, but is, so to say, always engaged in poising innumerable arrows, before hurling them upon his victims.

Indeed, the beneficial results of steps now taken are so marked, that we may well hope for a further extension and amelioration of human life in the future. One cannot hope to gain an indefinite prolongation of earthly existence, for human beings might then resemble the wretched creatures depicted in "Gulliver's Travels." However, no one likes the idea of an early end, and we may reasonably look forward to living the longer, in proportion to the care exercised.

According to W. M. B. Synge, our predecessors in England lived without several luxuries for many years; without coal till the fourteenth century; without butter and bread till the fifteenth; without tobacco and potatoes till the sixteenth; without tea, coffee, and soap till the seventeenth; without umbrellas, lamps, and puddings till the eighteenth; and without trains, telegrams, gas, matches, and chloroform till the nineteenth.

It is obvious that these things have added a great deal to the pleasantness and the potentialities of life.

Such changes as increase human happiness are desirable. There are still many things that are wrong, and, by careful study, we may find out how to eliminate the obstacles that stand in the way of the attainment of old age and natural death, which last is probably rare, but painless in the few cases in which it occurs. It is one great mistake, for instance, to suppose that luxuries bring happiness, for often they really cause misery and disease. Probably the simple mode of life of uncivilized races is better in many ways than our own. For example, the delicious dishes of modern cookery may stimulate the organs of digestion unduly. Modern clothing and buildings, too, are not always conducive to health. Not only may they both, as now used and constructed, make us too tender; but also they are not really at present the best possible.

The question of the differences between the savage and the civilized life is complex and highly interesting. Doubtless there are many destructive influences in the uncivilized state; but, on the other hand, some of the luxuries of society are also destructive at times, and frequently debilitating. Again, the savage has but few means of restoration for the sick; but possesses greater resisting power as a rule to unfavourable climatic conditions and changes.

It is a human custom to disparage the aged; but there is no doubt that ripe experience and judgment are only attained to by those who have lived long, and hence the old are far better able to advise in regard to politics and the administration of justice than are the young. The deepest wisdom only comes after many years of life.

It was formerly the custom to extend the idea of altruism to humanity at large. It can safely be extended to the nation, and also to all civilized races; but it is doubtful if we can rightly regard the more savage peoples as coming within the pale of equality.

There is still much to be done. Many modern customs must be reconsidered, some require to be remodelled, and education especially must be altered. A full recognition of the meaning and object of life

should unite all civilized nations in an ideal bond of union, whereby a lessening of the sorrows and an increase of the happiness of the human race might be arrived at. It is very important to note that by no means the best way of carrying out such aim is that usually adopted, viz., the gathering of people into large public assemblies in halls and rooms. These have their use ; but they are at times dangerous by focussing, and therefore magnifying, infection, and in any case they need to be supplemented by other measures.

Chapter II.

DURATION OF LIFE IN MANKIND AND INJURIOUS OCCUPATIONS.

Duration of Life in Mankind.

For the consideration of duration of life in animals other than man, and in plants and trees, the reader is referred to the Appendix A, as the subject is necessarily incompletely discussed, and is, moreover, somewhat abstruse. In this chapter longevity is dealt with merely in reference to human beings.

Very erroneous are some of the ideas prevalent in regard to the subject of the duration of human life. On the one hand it has been maintained, and not without meeting with some acceptance, that Old Parr really did attain to the age of 152, and that Henry Jenkins lived to be 169 years old. Yet, there is not a tittle of evidence to prove such extravagant tales, though many people believe them. On the other hand, men so frequently see their fellow-creatures dying at a very early age, that they may be, by this consideration, led to suppose that the ordinary low limit of life is natural and inevitable. The consequence of this is that we may be led to acquiesce in what we think to be the general case, and it is by no means an unusual circumstance to find that many persons regard avoidable risks as if they were inevitable, and hold that human beings ought not to expect to live even to such a reasonable age as 90 or 100. The average duration of life of the inhabitants of Great Britain is now about 48 years ; but, whilst several have reached the age of 80, 90, perhaps not one in 100,000 attains to 100, some—perhaps not one in some 200,000—live to 105, and it is doubtful if any human being can be proved to have lived to 110 years. We append here in this connection a cutting from *Reynolds' Newspaper* of Nov. 24th, 1907, describing a death at 106 years of age.

" Granny " Lamb's Death at 106.

" I am very tired of it all ; I don't want to see another Christmas or another birthday," were among the last words uttered by Mrs. Sarah Lamb, who died on Tuesday morning in St. Pancras Infirmary, in her 106th year. It was the expression of world-weariness in one who had long outlived the natural span.

Mrs. Lamb, who is described by the matron of the infirmary as " the dearest old granny," was born at Ramsgate on September 24, 1801, and had resided in London practically all her life. She married a pianoforte artisan, who left her a widow thirty-six years ago, and she was the mother of several children, all of whom died before her. Up to the last the old lady, although bed-ridden, maintained most of her faculties.

In her more cheerful moments she would relate how she had lived under five Sovereigns, and she recollected being told to curtsey as King George III. passed by. She had had many opportunities of seeing George IV. and William IV., and, of course, the late Queen Victoria. At the time King Edward came to the throne, she was an inmate of St. Pancras Workhouse, and it was one of her happiest reminiscences to describe how she was driven in a cab to Buckingham Palace in order to see His Majesty.

It has been said that the tendency to live long is hereditarily transmitted, and to some extent at least this statement is probably quite true. Manifestly it will be more pronounced when both parents have been long-lived. Some persons fragile and delicate, and some even deformed, have reached a good age. Again, some long-livers have been dull, others bright, some cleanly, others uncleanly in habit. Some, indeed, have been gifted with but little of either physical or mental capacity. In fact, the weak, as well as the strong, may retain vitality for long, and long-livers do not seem to be endowed with the power of resisting the more fatal maladies which are liable to afflict mankind. The age to which any given fairly healthy person free from acquired disease may expect to live may be arrived at by adding together the ages of the father, mother, father's father and mother, and mother's father and mother, and dividing the total of these by six. If any of the six persons mentioned have had their lives shortened by injury or accident, due allowance should be made. After dividing the six ages by six, one should add or subtract one year for every five that the result exceeds or is less than 60, and the number obtained would be that of years to which only one in nine in this country reach.

Great length of life is not exclusively met with in the rich, and those exempt from the cares of business, who number about one-sixth of the population. On the contrary, it frequently occurs in asylums and workhouses, for the simple reason, probably, that the inmates are entirely free from anxiety as to their needs and creature-comforts. In 1901 the proportion of workhouse paupers, aged 85 or more, to one million of same age in the country was very nearly 1 in 10. They are well and regularly fed, and, luckily for them, prevented from inordinate eating or drinking or working. They are also well clothed, housed in comfortable rooms, bathed, and kept so far as possible protected from all risks of infection. It may, indeed, be not infrequently the case that even the wealthy and high-placed may be living under conditions of a far less healthy character. Moreover, the inmates of such institutions are obliged to live regularly, and whilst occupied with tasks sufficient for the exercise of their bodies, are not submitted to stress of any kind. The lack of perfect freedom is, to such as need some restraint, in reality an inestimable boon. They are, for example, debarred from any undue indulgence in strong drinks, tobacco, and other pernicious habits, falsely seeming to be pleasant to some. The dietary, too, is such as is suitable, and there are many persons outside who would really be better off if put upon a workhouse regimen. Temperance, even though involuntarily practised, is conducive to the well-being of

the body, and workhouse inmates are really much better off than they would be if left to their own devices, and the quiet ease of their lives affords a striking contrast to the harassing cares which so often prey upon other classes, from the labouring man with wife and family dependent upon his exertions, to the highest in the land.

No doubt the inhabitants of civilized countries have a higher average longevity now than in former times, and the ratio of average length of life now to that of a hundred years ago, may be said to be about that of 4 to 3. This may be put down to greater knowledge and application of hygienic principles, which also saves about 120,000 lives annually, and is said to have added about 1¼ inch to the average height of human beings in a period of about 1000 years.

With regard to the old ages recorded in the Bible, Hensler stated that one year in the time of Abraham was really a period of three months. At a later time it was prolonged to eight months, but not until the time of Joseph was it computed as twelve months, and it is said that there are some Eastern nations who still compute it as three months.

Extremes of heat and cold are both unfavourable factors. In tropical countries, the body is quickly matured, decay comes on at a rather early age, and life is consequently short. There are, of course, several influences which tend to abbreviate the lives of savages, one of which is their helplessness in regard to diseases and sanitary matters. On the other side there are also favouring causes. In the case of some, their religious beliefs do not aid long life; and others, as in the case of the Fiji Islanders, who think they go into the next world with their bodies as they are in this one, and therefore had better die before decay has really started, materially shorten it. These Islanders therefore seldom exceed 45 years of age. Life, too, is short in the Papuans of New Guinea, who may very exceptionally live to be 60, but as a rule die before 40 or 50. Life, however, is, perhaps, even still shorter on the average in the West Indies and Abyssinia.

In climates not so hot, growth is more gradual and life generally longer. Yet, though great heat is not conducive to human life, great cold is still more detrimental, for human beings can stand heat better than cold. The temperate climate of England, and also the climates of Denmark and Norway, are more favourable; but where it is severely cold, as in Iceland and Northern Asia, the usual longest duration of life may be said to be about 65, with a possible extreme limit of perhaps as much as 90. In Greenland and Nova Zembla, where the highest degree of cold is reached, a still lower range exists.

Though the ancient Egyptians extolled the benefits of a dry air, yet it has also been held by authorities that atmospheric humidity adds a certain suppleness to human bodies. Thus life is said to be longer in islands and peninsulas than in the interior of continents. It is really probably a question mainly of proximity to, or distance from, a healthy seaboard. Or, perhaps, proximity to lakes may be also beneficial; but of course there are in each case many special factors involved,

and sometimes low-lying localities are malarious. At any rate sea-air is a powerful restorer of health, and probably directly conducive to long duration of life. Its exhilarating effect is due partly to the ozone, and possibly also to the salt contained in it. A still more potent cause of its salubrity as compared with the air of towns and densely-inhabited places is its freedom from germs—a freedom partly due to their absence, and partly doubtless also to the fact that the very composition of the air renders their life almost impossible if they should happen to gain access. Air at a distance from land is almost free from germs, and air taken from a high elevation is also almost quite pure, and to some people even more exhilarating than sea-air, because containing so much less aqueous vapour, and being of so low a density. However, it is too rarefied for some—especially those with diseased or weak hearts.

On the other hand, the dwellers in low-lying places, especially where marshy and boggy land predominate, are seldom long-livers. The negro in Senegal lives a shorter time than in America. Nationality, whether due to the habits of nations or heredity, has some influence, as, for instance, the average life of a Prussian has been said to be 28·18, that of a Schleswig-Holsteiner 39·8, and that of a Neapolitan 31·65 years. These figures are, however, not exact for the present time.

It has been said that 14 per cent of all born in Great Britain now may attain 80 years, and that out of every million born half die before 45, whilst the age of 50 is reached by 464,000, that of 60 by 369,000, that of 70 by 237,000, that of 80 by 90,000, that of 90 by 500, that of 95 by 2153. The average expectancy at 60 is 13½ more years, at 65 nearly 11 years, at 70 about 8½ years, at 75 about 6½ years, at 80 about 5 years, at 85 about 3¾ years, at 90 about 2¾ years, at 95 a little less, at 99 nearly 1¾ years. Of course it is obvious that the expectancy of life is not merely a varying quantity at the outset, but also very greatly modifiable during the progress of each one's life, by all the complex factors concerned. It differs, too, in the various races. For example, the proportion of the population that reach 70 is in Norway one-third, in England one-quarter, in France one-eighth, and in Ireland one-eleventh.

In each country also it increases concurrently with the advance of sanitation. For instance, in the 17th century the average expectancy was only 13, in the 18th it was 20, in the early part of the 19th it was 36, in 1854 it was a little under 40, in about 1885 it was 42 for men and 44 for women, in 1900 a little under 48. Women, as a rule, live about two years more than men. The death-rate in old cities has been lowered one-third, and in new towns one-half.

The following table shows the number of deaths per 1000 per annum at different ages. It will be seen that if four years of life be passed, the expectancy is very greatly increased, and even an age of 75 may be reached, of which the first 25 are those of growth, the second 25 of maturity, and the third of decay.

Deaths per 1000 of the Population per Annum at Different ages.—(Schofield.)

	General Average at all Ages.	At Years 0 to 4	4 to 12	12 to 20	20 to 34	34 to 54	54 to 70	74 to 90
Male	23	71	6	5	8	18	49	229
Female ..	21	62	6	7	8	23	43	220

The chief point is the high mortality of children under 4, owing to the fact that ignorance, carelessness, and neglect are then most marked and least easily resisted, the infants being then both very fragile, and also unable to protect themselves. The deaths during the first 4 years nearly equal those during the next 70 years. One year before the fourth is as dangerous as seventeen years afterwards. The mortality of 70 per 1000 under 4 drops at once to 6 when over 4, and so fatal a period is not again reached. As many die in the first five years as die between 40 and 70; the safest years are between 25 and 45.

It may be said that some 150,000 die needlessly every year in Great Britain, and that some five millions are ill from avoidable causes. Unsuitable food is the cause of three-quarters of infants' deaths, whilst alcoholism is the cause of many adults' deaths. Bad air causes most lung diseases, which include three of the five most fatal diseases in this country.

There is an increase of both male and female survivors to the age of 80, and though fewer males live to 90, more women do so than was the case sixty years since. Again, the number of centenarians for every 100,000 of the population was said to be, in the period from 1838 to 1854, of men 15, and of women 30; whereas in the period from 1891 to 1900, there were only 7 male and 24 female centenarians. These last figures are probably more near the truth, as veracity in regard to age has perhaps increased owing to various causes.

At the census of 1851, 319 persons, of whom 111 were men and 208 women, stated themselves as ranging between 100 and 119 years of age. Of these 69 were widows having no occupation, 16 were agricultural labourers, male and female, and 19 were farmers.

The census of 1861 gives a list of only 201 centenarians. For full statistics the reader is referred to other works on hygiene; but it may be stated from the figures of 1881 to 1890 that out of one million English males born, 30 lived to be 100 years old, and out of one million females born, 157 lived to be the same age, and to 95 lived 752 males and 2124 females.

Many causes of disease are being obviated, and the duration of human life is becoming greater in consequence thereof. Antiseptic methods have doubtless favoured longevity, and will still more do so, in proportion as they are more skilfully carried out.

With reference to the surgical treatment of wounds in war, the mortality of the wounded English in the Crimean war was 15·21 per cent;

in the French, in Italy, in 1859–60, it was 17·36; in the Germans in 1870–1, when antiseptics were used, it was 11·07; in the Spanish-American war in 1898 it was 6·64; and in the Transvaal war it was about 5·51, i.e., less than half that of the Franco-German war. Finally, in the late Russo-Japanese war there was great surgical success in the Japanese quarters. Both sanitation and mortality in war affect the average longevity.

Mortality from surgical operations, childbirth, diseases of the blood, erysipelas, etc., will be greatly diminished by antiseptic treatment. The deaths from childbirth alone, including puerperal and septic diseases, sank from 385 per million in the decade 1861 to 1870 to as low as 295 in that from 1891 to 1900.

It has been said that two men out of every twenty-three, and one woman out of every eight, who attain the age of 35, are likely to die of cancer, and these figures are based on the Registrar-General's last report, but they probably need overhauling and correction, as sources of error are apt to creep into such estimates.

The ignorance of many simple truths, and the disproportioned impulses and evil tendencies which influence human beings, render their lives unhappy, unhealthy, and miserable. A great number of people are not aware of the laws of health, and hence, owing to ignorance or carelessness, succumb to some illness which might have been avoided. Even the robust may die through careless habits. It is not unusual to see persons of 30 or 40 showing stiffness, and general failure, which should only be seen in the old. Dissipation, luxurious pleasures, and anxiety do greatly shorten life.

One point of some considerable importance in regard to the duration of life is that Mr. Flourens has shown that both animals and human beings continue to grow until the time when the epiphyses (or soft extremities) of the long bones are united to the shafts. He gives the supposed length of life of several mammals, and also the age at which the epiphyses of their long bones are united to the shafts, and infers that the length of life is five times that of the period of growth.

Thus the union occurs in			cats at	18 months,	and they live			9½	years.
,,	,,	,,	dogs at	3 years	,,	,, about		12	years.
,,	,,	,,	oxen at	4 ,,	,,	,,	,,	20	,,
,,	,,	,,	horses at	5 ,,	,,	,,	,,	25	,,
,,	,,	,,	camels at	8 ,,	,,	,,	,,	40	,,

Buffon had previously thought that the relation of period of growth to length of life was 7 to 1. At any rate the ratio is not probably an exact quintuple one, though there is doubtless some relation of length of life to bulk, intensity, and vigour of life, and, perhaps, sometimes an inverse one to generative expenditure when excessive.

Now the union of the epiphyses with the shafts of the long bones occurs in man at about 20 or 21 years of age. The duration of the period of growth being calculated to be about one-fifth of the natural life, consequently men and women should continue to live until they are 100 or even 105 years old. Still, only about 6 per cent reach 60

years of age. Deaths happening earlier may be regarded as avoidable, if we admit this ratio to be stated correctly. However, this rule that animals live five times as long as the period occupied in growth is only an arbitrary one, and not proved to be exact. It is probable that the natural limit of life in mankind is not definitely expressible, but variable. In many cases it should be more than a hundred, and only exceptionally much less than that number.

It has been stated by an eminent savant (Metchnikoff), that in time to come men may live as long as 120 years if all hygienic precautions, both public and private, are thoroughly well carried out. Many die at about 50 owing to overwork, who with care should have lived to be 90. Just as life varies in other respects, e.g., as to the date of generative maturity, so it varies also in capacity of natural duration. Accurate rules cannot be laid down—only approximate and conditional ones being possible in such abstruse matters.

One point is that diseases should be detected in their early stage. It is also noteworthy that tendencies to the contraction of alcoholism, or other forms of indulgence, can be best counteracted at the outset, before they have got a firm hold. The same remark applies to definite diseases, such as tuberculosis and the malignant tumours. If treated in their initial stages, these conditions can be removed, or at any rate very much mitigated in regard to their effects. Hence, it may be wise to ask some able and experienced medical man to examine the members of a family about once a year at least, so that any signs of illness may be detected as early as possible.

According to Mr. Thoms, any evidence which can be adduced of any human being having lived as long as 110 years is on enquiry proved to be absolutely worthless. This same able writer on the subject of longevity mentions seven well-established instances of persons having lived beyond a hundred years, and of these the one who lived the longest is Mr. Jacob William Linning, who died on June 23rd, 1870, aged 103 years, one month, and four days. Many similar instances have been recorded, and several persons are said to have lived to a greater age, though one cannot believe that the true facts are always accurately known, as there is probably no subject more likely to be fraught with error than that of longevity. However, one point seems to be clear, and that is that to live a long time is not by any means the privilege of a class, but is brought about by such natural factors as vigour of constitution and carefulness of conduct.

It has been said that longevity may be especially attributed to the possession of a good sound heart and blood-vessels. Yet even diseased hearts may not cause early deaths, if due care be exercised. Naturally we should be unconscious of the action of the heart, and, indeed, of most vital processes, such as digestion, respiration, circulation, and so on.

Physical unconsciousness, i.e., no feeling of a burden of the flesh, is a sign of health—when one moves, thinks, lives without knowing an effort in doing so. Healthy life is a condition of change in which the

two functions of destruction and repair are balanced. Daily one-twenty-fourth of the body dies.

Excess of any kind may lead to heart-strain, and young people should be cautious in this respect. Sir Hermann Weber advises that the brain and nervous system should be especially kept in good action. Of course, it should not be over-pressed at any time. Brain-work improves the circulation. A very frequent cause of death is degeneration of the blood-vessels of the brain, and this degeneration is avoidable by the use of great moderation in food, regular exercise, and judicious mental work and occupation. Alcoholic beverages and tobacco should be either entirely unused, or only used in small degree, and with great judgment. Cheerfulness should be cultivated, and self-control exercised in regard to ambition, avarice, jealousy, and racial desires. The will-power to restrain one's inordinate impulses should be sought, and strengthened.

1. Food should be suitable, moderate, and wholesome.
2. Air should be pure.
3. Clothing sufficient and suitable.
4. Regular exercise should be taken, and also bodily work done, and the intellect employed, with intervals of repose when required.
5. One should retire to bed at an early hour.
6. Take daily bath, or at least carry out a thorough ablution. Practise scrupulous cleanliness, and care of the bowels.
7. Be cheerful, and control the passions, and fears due to nervousness.
8. Check cravings for stimulants and anodynes.

Speaking generally, country life is healthier than a town one. Dry subsoils are good, and damp ones unhealthy. An open situation where the sunlight can amply enter is best. An open fireplace is better than pipes for heating, because by it ventilation is aided, as well as warmth secured. Finally, the environment and surrounding circumstances should suit one's temperament. Moltke said that he kept healthy by exercising great moderation in all things and by regular outdoor exercise. Sir B. W. Richardson counselled abstinence from smoke and drink, excess of meat, and worry, though later he did not condemn the use of light wines, when a little stimulant was requisite. Doubtless, worry and hurry are very bad, and also over-pressure, such as is so often exacted by examinations. These are all the more wrong if combined with under-feeding of, or with lack of vitality in, the competitors. Signs of the bad effects of over-pressure may be seen in change of temper, sleeplessness, wrinkled forehead, marks under the eyes, dislike to sounds or lights, restless and purposeless movements, 'habiting,' retraction of head, vomiting, neuralgia, dyspepsia, loss of weight. Boys and girls should weigh about half the number of their years in stones, e.g., 4 stone at 9, 5 at 11, 6 at 12½, and 7 at 14. Boys should weigh 8 stone at 15, 9 at 16, 10 at 17; girls 8 at 17, 9 at 20, 10 at 22. Deviations from these of half a stone should be seen to.

When between 3 and 4 feet in height, a child should increase 2 lb. in weight for each inch, and when between 4 and 5 feet high, 2½ lb. for each inch of growth. A child should grow not less than 2 and not

more than 3 inches in a year. When food is scanty, more boys are born; when plentiful, more girls. The best age for marriage is for women 21 to 28, for men 28 to 35.

A man of about 6 ft. in height should weigh about 13 stone. A woman should be about 5 ft. 4. in. high, and if so, should weigh 9½ stone. The following table gives weights which should go with different heights :—

HEIGHT. FT.	INS.	WEIGHT STONES.	HEIGHT. FT.	INS.	WEIGHT. STONES.
5	6	10¼	5	10	12
5	7	10½	5	11	12½
5	8	11	6	0	13
5	9	11½			

Injurious Occupations.

Of the different classes in the community, the death-rate in the year 1885 was lowest in the clergy, who seem to live the longest on the average, and, beginning with them, the following was the order in which the various occupations stand :—

Clergy, dissenting ministers, farmers, agricultural labourers, grooms, lawyers, drapers, coal-miners, watchmakers, artists, shoemakers, bakers, clerks, chemists, greengrocers, tailors, doctors, butchers, painters, musicians, cab and bus men, sweeps, publicans, metal miners, hawkers, London labourers, barmen. The risks are greater in some occupations than in others. Clergymen die at the rate of 55, and potboys at the rate of 220, per thousand, and the intermediate classes at intermediate rates.

The comparatively brief tenure of a doctor's life is doubtless due to the anxieties inseparably connected with the work, and partly also to the risks of infection, which may often produce weakness, even when the illnesses themselves may be apparently escaped. Such weakness may even pass unnoticed, so customary may it be.

The high rate of mortality in some sections, such as cab and omnibus men, publicans and barmen, hawkers and London labourers, is probably partly due to drink, partly also to foul air in the case of the publicans and barmen, and sometimes in that of London labourers.

With reference to several deleterious occupations, it may be said that they are often so owing to the fact of their introducing poisons into the system. Now these, of course, impair the health, or actually destroy vitality, and hence abbreviate the average longevity. They may be gases, liquids, or solids, and may enter the system through the skin, either unbroken or wounded, the mouth and stomach, lungs, or even in very exceptional cases the rectum. Ultimately, if dissolved in fluid, they get into the blood, which is thereby altered for the bad, and they may finally be excreted by the kidneys, skin, and mucous membranes, even soon after ingestion.

Dust is very liable to act as an irritant. Inhaled dust of various kinds is liable to cause sneezing, coryza, and afterwards cough with expectoration of mucus containing dust, and dyspnœa. In some

cases it is thus seen to resemble influenza, which, indeed, it may really be, if the germs of that malady be conveyed by the dust. If the inhaling of even simple dust be long continued, in time the lungs become hard and perhaps emphysematous, and there may be pleural adhesions, and sometimes even effusion, in those employed in occupations which involve the inhalation of metallic or mineral particles.

Sweeps suffer from the inhalation of soot. Though the health of colliers is as a rule good, especially of those working in mines in the North of England, wherein the ventilation is generally efficient, partly because they are generally strong men; still they are liable to be affected by fragments of anthracite or bituminous coal inhaled into the lungs, which after death may be found to contain sharp particles causing minute abscesses. Metal-miners may die from inhalation of metallic dust. For example, the Cornish tin-miners, who inhale a very irritating mineral dust, show a very high mortality from phthisis. Also the fine particles of steel dislodged in grinding saws or other tools give rise to "saw-grinders' consumption," as in saw-grinders, file-makers, and cutlers. Similarly, quarrymen suffer from lung-disease caused by inhalation of particles of stone-dust. Makers of earthenware also suffer high mortality from "potters' asthma," caused by the angular particles of silex coming from the dust of the clay used in potteries. Similarly, in "china-scouring," women brush off flint dust from the china after it has been baked, and the clouds of dust damage their lungs.

"Ganister" is a hard silicious stone obtained by blasting with dynamite. It is crushed and ground wet, and then moulded into bricks which, having great power of resisting fire, are used for lining the bottoms of Bessemer converters and crucibles for moulding steel. Now phthisis occurs in ganister-miners ten times as often as in ordinary males of the same age, and also to a much less extent in those who work with the material on the surface. The dust causes fibrosis, which favours a subsequent attack of tuberculosis.

Again, in button-making, and especially in the cutting and polishing of mother-of-pearl buttons, as at Birmingham, the heavy dust causes fibrosis of the lungs. Also the pin-pointing and needle-making at Redditch cause much lung-disease, as also does electro-plate-making, in which articles are rubbed with a polishing-powder.

Dust, and fragments of wool, flax, cotton, and other materials in cloth factories, cotton mills, drapers' warehouses, and establishments of the like kind, may bring on bronchitis, anthrax, and other diseases, and precautions should be used against such dangers.

Lead-poisoning occurs in plumbers, painters, glaziers of pottery, file-makers, type-setters, makers of glazed playing-cards and of artificial flowers, those who use white lead for "throwing up the pattern in lace," and those engaged in the making of white lead, especially by the Dutch process. Those engaged in white-lead works, by strict care and cleanliness, may largely avoid the danger. Lead-poisoning causes a blue line on the gums, colic, and so-called "gout."

Devonshire colic, the origin of which was not known for many years, was at last found to be due to the lead from the lead-lined tanks which the farmers used for fermenting the cider.

Copper-poisoning occurs, and is sometimes known as "copper colic." "Brassfounders' ague" springs from inhalation of metallic dust in brass foundries. Its symptoms are similar to those of ague, but are not truly periodic. It has been said to be due to fumes of zinc oxide, but it is really due chiefly to copper and brass being absorbed. Flour is generally innocuous when inhaled, but on the Continent is sometimes adulterated with sulphate of copper.

Mercurial poisoning occurs in "water-gilders," who use an amalgam of mercury and gold, in silverers of mirrors, and makers of thermometers.

Arsenic-poisoning occurs in the manufacturers of arsenical wall-papers and artificial flowers, and also perhaps occasionally in those who inhale the dust from walls thus papered, if certain compounds of arsenic have been used in the colouring of the papers. It has also occurred from drinking beers which contain arsenic.

The fumes of phosphorus cause necrosis of the jaw, as well as other symptoms of poisoning; but the red amorphous kind is now used instead of the yellow kind, which caused the disorder in match-makers.

The making of bichromate of potash gives rise to dust which causes irritation and ulceration of the lining membrane of the nose.

The makers of Portland cement get lung-disease from the dust, and also during the burning process traces of cyanogen compounds arise.

The making of superphosphate manure causes vapours of fluoride of silicon.

The making of vulcanized indiarubber causes the evolution of carbon disulphide.

Bleaching works give off sulphur dioxide, whilst sulphuretted hydrogen comes from the making of some chemicals, and hydrochloric acid vapours arise from alkali-works.

Naphtha is used as a solvent in rubber-works, and its fumes cause indigestion, headache, giddiness, and nervous excitement.

Nitrobenzine causes drowsiness and even coma. The use of roburite, an explosive employed in mines, causes those symptoms, and they are probably due to the nitrobenzine. Similar symptoms occur if "Sicherheit explosive" be used. The symptoms of workers in melanite are probably due to picric acid.

In some weaving sheds the air is steamed, and hence hot and humid, and impurities accumulate.

CHAPTER III.

THE GERM THEORY, NOTIFICATION OF DISEASES, AND PRECAUTIONS AGAINST INFECTION.

THE GERM THEORY.

IN a somewhat different sense from that in which we now understand the germ theory, it has been said to have been enunciated by Pliny. The idea that diseases were caused by living germs was ably advocated by the famed Linnæus more than a century ago. By this hypothesis the origin of certain specific contagious diseases is attributed to the presence of microscopic vegetal organisms, called microbes, in varying parts of the system, e.g., in the tissues, skin, organs, lymph, or blood, or in some or all of these. The microbes are supposed to be the direct producers of the particular diseases in association with which these germs are thus present. The idea that the diseased condition comes prior to the germs, however, cannot be entirely put out of court. It is a possible view.

Kircher, in his work called "Contagium Animatum," published in 1671, referred to the possibility of diseases being produced by animalculæ; and Linnæus stated that ailments might be caused by multiplication of specific infective agents within the body. Again, Schwann and others stated that fermentation and putrefaction are caused by micro-organisms introduced from outside. Pasteur, in 1857, showed that lactic acid fermentation is caused by special germs, and later that ammoniacal fermentation of urea is also, and he also elucidated silk-worm diseases. Davaine, in 1863, stated that the threads he had, some years before, observed in the blood of animals affected with anthrax were the cause of that malady. Pasteur explained the method of protective inoculation in regard to fowl-cholera and anthrax, and also a mode of treating persons who had been bitten by rabid animals. Lister advocated the antiseptic treatment of wounds. Koch investigated cholera, and in 1882 he discovered the tubercle bacilli, and also devised a better means of fixing growing colonies of bacteria in gelatin.

The growth of microbes in pure cultivation on artificial media has removed misconceptions regarding the "mutability of species," and has rendered precise study possible respecting "involution-forms," and also that of modifications of power to produce particular chemical changes, and also of attenuation and loss of virulence. Possibly some germs may be able to develop outside the body into organisms not at present known to be connected with disease. The spores of

anthrax bacilli can render hides and skins infective, such infectiveness being even retained after long exposure and conveyance from one end of the world to another. Possibly also other germs may possess the power to assume resistant phases, and so cause disease in man, the previous case of that same disease being thus rendered quite untraceable.

The increase in severity of the symptoms is, in most cases, attributed to the rapid and progressive growth of millions of the organisms; but in the case of diphtheria and tetanus the germs multiply only, or almost exclusively, locally, and to a small extent, and in these cases it is to the toxines to which they give rise, and which are probably widely distributed by the blood, that the symptoms are due.

The infectiousness of the communicable diseases is thought to be due to the immense number of minute spores given off from the suffering ones. These are air-borne, and probably often attached to epithelial scales rubbed off from the bodies. Every person affected with infectious disease continually gives off from the skin, the breath, and the secretions, millions of spores so minute that 20,000 placed in line would not measure even one inch in length. A group of them as big as a grain of sand would contain very many.

Some diseases are communicable from man to animals, and *vice versa*. The contagia are micro-organisms, capable for the most part of living either inside or outside the body, belonging to the large class called schizomycetes, the lowest of vegetables, including bacilli, micrococci, spirilla, vibrios, etc. These exist in enormous number in the air, water, and soil, in every region and climate, and, together with yeasts and moulds or fungi, cause those changes of fermentation and putrefaction to which all organized structures are liable.

The least amount of virus of small-pox produces the disease in a susceptible patient; but the amount produced in that one body would suffice to inoculate many thousands. The virus of a disease may lie dormant in clothes or furniture for long periods. The spores of bacteria can resist extremes of temperature and drying, which the bacteria themselves cannot withstand. However, in some diseases the virus cannot live outside the body. Anthrax is an example of an "infection" in which the bacilli invade the whole body. Tetanus and diphtheria are "intoxications," the bacilli being localized, and their toxins absorbed.

Recovery from tubercular lesions is not uncommon, yet it seems that no immunity is thereby conferred.

For sixty-five years the inhabitants of the Faröe Islands, an isolated group in the North Sea, had been free from measles, when, on the 1st of April, 1846, a workman from Copenhagen, who had arrived three days before, fell ill with this disease. His two most intimate friends were next attacked, and from that time the malady was traced by Dr. Pannum, the Danish Commissioner, from hamlet to hamlet, and from island to island. At last 6000 out of a total population of 7782 persons had been affected by it. The disease was found to spare all those who had suffered from it in their childhood at the time of the previous epidemic more than sixty years before.

Notification of Diseases.

It may be difficult at first sight to those who believe in the freedom of the subject being, so far as possible, unrestricted, to see the great benefits to be derived from compulsory notification of infectious diseases ; but there can be no doubt that it is a wise provision on the part of the State that infectious diseases should be notified.

Such terrible mortality may occur from some maladies that one cannot but conclude that it is necessary for the governments of countries to take all reasonable precautions against the propagation of an epidemic. As an example of this necessity an extreme case may be mentioned. We learn from *The Times* of Dec. 5, 1907, discussing a notice of the work of Dr. Haffkine respecting "Plague," communicated to the Epidemiological Section of the Royal Society of Medicine, that five million persons have died of plague in India since the disease was diagnosed in Bombay in 1896, and the loss and suffering can hardly be realized. Very many villages have been practically depopulated in the Punjab and the Bombay Presidency. Stricken cities have been temporarily left desolate. History reveals hardly any visitation of disease comparable with this huge mortality in India. Indeed, since the Black Death of 1348 no such outbreak has been recorded. Cholera and sleeping sickness, and other diseases such as leprosy and cerebro-spinal meningitis, have each claimed their myriads of victims ; but it is probable that plague has caused the deaths of more than even sleeping sickness, though the occurrence of large losses from this last disease has only recently been noted. The Indians should co-operate and practise a more complete sanitary system.

The rat infects the rat-flea, which conveys the infection to man. Hence rats should be destroyed, and dwellings made rat-proof. Inoculation with Dr. Haffkine's prophylactic confers at least temporary immunity.

Four million people or more die of fevers in India every year.

Some maladies, like consumption, might be notifiable, that at present are so only in some towns in this country, and in some only to a limited extent, for instance, so far as poor-law cases are concerned. The most usual method whereby human diseases are propagated is directly from human being to human being, and hence the most effectual means of prevention is the isolation of those who are smitten by infectious maladies. Much more harm is done by public assemblages than is easily realized, and, in order to keep clear of infection, it is best to avoid crowded buildings. The open air is better than any that can possibly be present in closed places.

There is no doubt that diseases are often spread by aggregations of people, and that public-houses, theatres, schools, and other buildings wherein people congregate, are liable to become dangerous, unless great care in ventilation and disinfection be exercised. Sunlight and fresh air are powerful preventives of disease.

An internal complaint that is not obtrusively manifest by any visible signs, and is, therefore, unknown and kept secret from others,

does not damage a person in the general opinion so much as a palpable deafness, blindness, lameness, or other defect which cannot be concealed. However, it is clear that a human being may have far greater disabilities which are entirely unknown to the observer.

Precautions against Infection.

Anyone suffering from an infectious disease should be placed by the medical attendant under the charge of a skilful nurse, preferably one protected by a previous attack of the same malady, or, in the case of small-pox or plague, by a previous recent vaccination. The sick-room should be kept private, no one entering save those directly authorized to do so. The nurse should wear a loose gown and nicely-fitting cap. Her outer garments should be doffed, and hands and face carefully washed with carbolic, terebene, perchloride of mercury, or other antiseptic soap, before leaving the room. Similarly, the physician should put on a protective gown before entrance, and doff it before exit. The room, or rooms, in which the patient is secluded should be as much isolated as possible, and perhaps an upper storey is to be preferred. All curtains, carpets, and unnecessary furniture should be removed. A fire should be lit, and kept burning as a rule both day and night, in order to preserve a warm and equable temperature, and for destruction of dressings, pocket-handkerchiefs, or other waste material, and for ventilation. For this last purpose, too, a window, if not too near the bed, or other mode of ventilation, should be left open, care being taken to avoid draughts so far as possible. In order to sweeten the air, a spray of sanitas, thymol, chloride of lime, or other deodorant, may be used. Also a sheet kept moist with a solution of carbolic acid, of the strength of half-a pint to a gallon of water, or other disinfectant, should be hung over the outside of the door, or in the passage, for the purpose of destroying germs, or preventing their escape. No food and no utensils nor appliances should be removed from the sick-room without first being disinfected. For instance, glasses, cups, dishes, should be cleaned with permanganate or other antiseptic solution. A basin containing some sanitas, izal, chloride of lime, or solution of carbolic acid (one fluid drachm to half a pint of water) should be at hand for the patient to spit into. The clothing and bedding may be changed as often as is needful and convenient; but the cast-off materials should not be carried dry through the house. In order to obviate this dangerous practice, a large tub or vessel, containing a solution of four fluid ounces of carbolic acid to each gallon of water, should stand in the room, so as to be ready for the reception of bed- or body-linen. Subsequently, the clothing may either be destroyed, or boiled, or baked in an oven heated to about 240° F. Plenty of a 1–1000 mercuric chloride solution should be at hand, or the tablets for making it readily, and before the excreta are removed from the room an equal bulk of such solution should be added to each portion. Or the discharges may be directly passed into suitable vessels containing either this or some other potent antiseptic solution, such

as carbolic acid, or sanitas, or permanganate of potassium. In lieu of the ordinary handkerchiefs, old linen, pieces of rag, or even such paper as the Japanese use for that purpose, should be used, and after use burnt in the fire.

After the close of the case, final disinfection should be proceeded with, the patient being of course out of the room.

(*a*). All linen, cotton, and silk articles, which have been in the apartment, should be boiled for ten minutes, except dyed fabrics, and other special things.

(*b*). All movable textile articles which cannot be boiled, e.g. blankets, woollen materials, bedding, pillows, mattresses, curtains, hangings, carpets, rugs, must be taken away and disinfected by steam. Special care should be taken to disinfect all things that have been in contact with the patient.

(*c*). Other articles must be laid open as much as possible, whilst the room is thoroughly fumigated by sulphur dioxide, formaldehyde, or chlorine. If sulphur be used, a pound of it should be burnt for every thousand cubic feet of space. The room should be tightly closed up before the sulphur is burnt, and left thus closed for twenty-four hours.

(*d*). The furniture should be taken into the open air, and brushed, washed, or beaten.

(*e*). The walls, wood-work, ceiling, floor, and all surfaces, should be cleansed, sprayed, or washed with solution of carbolic acid and soap—especially in the crevices and corners. The paper should be stripped off the walls, holes being cemented up, and the walls and ceilings limewashed. The doors and windows should be left widely open for a week or longer.

A patient who has recovered from small-pox should be isolated for ten days after all the scabs have fallen off; after desquamation is complete in scarlet fever, and for the last week of seclusion, daily baths, each containing half an ounce of carbolic acid, or a larger amount of sanitas, should be used, and the scalp should especially be well washed, as the virus of the disease lingers in the scales situated at the roots of the hair.

Chapter IV.

CLIMATE—HEAT AND COLD—THE ACTION OF THE LUNGS AND SKIN—SPECIAL PRECAUTIONS FOR OLD PEOPLE.

Climate.

This word includes the chief features of a locality in regard to various factors, including temperature, barometric pressure, humidity, rainfall, prevalent winds, soil, aspect, conformation of country.

The averages of annual temperature and rainfall give merely rough, and sometimes erroneous, views respecting climate, for there may be great variations and extremes during the course of the year, and still a similar yearly average.

Nearness to the sea usually causes a temperate, even, and humid climate, whilst inland places have greater variability. Mountains cause greater rainfall. Forests keep the water in the soil, and lead to the production of springs. They diminish radiation of heat from the earth, and thereby make hot places cooler, and also increase the rainfall. Trees make the day cooler, and the night warmer, and also cold climates warmer.

Drainage raises the temperature of a district by lessening the amount of damp soil, and of aqueous vapour in the air.

For some invalids, especially such as have weak lungs, it is wise to resort to a milder and warmer climate towards the close of summer, so as to avoid our cold and wet winters. In many cases, however, provided they do not expose themselves unguardedly to cold, damp, and unfavourable winds, they may get on very well in this country. Moreover, they may fall victims to unfavourable conditions abroad. The talented writer known as Hugh Conway died in the zenith of his fame, of typhoid fever in a foreign land, and a rich, elderly lady, known to the authors of this book, contracted small-pox and died at Jerusalem.

Heat and Cold in Relation to Health.

The temperature of man varies with :—

1. Individual peculiarity to the extent of ·5° F.
2. Race. Natives of India and Iceland have it higher than natives of Africa.
3. Age. It increases up to fourteen years to 99° F.
4. Time of day. Least at 5.30 a.m., highest at 6 p.m.
5. Exercise. Increases it slightly.
6. Food. Causes slight elevation. Large doses of alcohol reduce temperature 3° F.

7. Temperature of air. An elevation of the environing air causes an increase of temperature and of respirations and heart-beats, until distressing palpitation and dyspnœa supervene. These effects are caused equally by the heat of the tropics or that of the Turkish bath, even the gradations of heat in weather or in climate being all productive of definite effects.

8. Diseases. Many cause increase in pulse, respirations, and temperature.

When the winter becomes very cold, rooms should be artificially kept at an equable temperature by hot-water pipes, or by fires.

A great deal has been heard of late as to the beneficial effects of sun-baths; but it should be noted that the direct rays have a powerful, and sometimes a dangerous, influence. If one notices animals, it will be seen that they generally select shady places to lie down for rest, and but seldom expose themselves for long to the direct rays. Their preference for the shade may be partly due to the seeking for protection; but it is probably also for the purpose of avoiding direct sunlight, though the two motives are doubtless inextricably combined. In any case we know that, in the case of human beings, exposure to intense heat from the sun is liable to produce sunstroke, which may rapidly prove fatal, and frequently is in tropical countries. It seems that the effect is due to the influence of heat upon the substance of the brain, and hence we should be careful about exposing ourselves to the sun's rays in very hot weather from 11 to 3 o'clock in the day. The precaution of placing a few green leaves in the crown of the hat may prove a valuable preventive of sunstroke. Should the initial signs of giddiness be observed and there be heat of head, the patient should be removed to a shaded place, and the head, neck, and chest be gently rubbed with a cloth first dipped in cold water and then squeezed dry, to reduce the body temperature to 98·4° F. A week wherein the daily temperature exceeds 95° F. may occasion diarrhœa and cholera infantum.

Extreme cold is more harmful than heat. Cold may give rise to frost-bite, affecting the nose, ears, and fingers, and digits of the feet. After prolonged exposure to cold, there is a marked disposition to sleep. When only small parts of the body, such as the tips of the nose and ears, have become frozen, the affected place becomes of a dull yellowish white colour, and in these circumstances serious injury may often be prevented by thawing it very gradually, as, for example, by bathing the affected part with ice-cold water, or by rubbing it with snow. Cold also acts as a disease-producing agent by checking perspiration, whereby more work is thrown upon the lungs and other internal organs. Again, cold causes a constriction of the little vessels of the skin, and hence the blood travelling to the internal organs causes congestion of them—of the lungs, liver, kidneys, and so forth—or diarrhœa may supervene. Especially ought we to be most careful in cold weather after violent exertion, or after a warm bath.

Although fresh air is essential, it is best to avoid undue exposure to draughts, or currents of cold air impinging on the back of the neck. Wind, if blowing fairly in the face, may generally be safely braved by fairly healthy people, or such as are used to it; but if it catches one at the back of the neck, behind the ear, or at the side of the head,

it is more dangerous, particularly for weakly people. Similarly, a largely open window is fairly safe ; but a slit or chink, through which the air is blown with force, should be avoided. It usually comes thus with more power, i.e., really in greater amount in a given time, and chills the part much more rapidly than air moving slowly. As is well known, cold, even when many degrees below zero, is not greatly felt, unless there be also wind, in which case it is well-nigh unendurable.

It is also wise to refrain from sitting near an open window or door, It has been shown that as much as forty-three gallons of air per hour can pass through every square yard of a brick wall. If one has got wet, all damp clothes should be removed, and the feet placed for a few minutes in hot mustard and water. If the exposure has been great, a mustard plaster may be placed on the back, and the patient be put to bed in a warm room. One or two cups of hot tea will also aid in causing perspiration.

The Air.

We may note that the world of living organisms is so composed that one kingdom, viz., the vegetable one, prepares the food for the other, the animals, by so altering the inorganic constituents of the earth as to render them assimilable by the latter. Extremely different as are the two kingdoms, they are, in this and other ways, connected by mutual interests, animals living directly or indirectly on plants, which derive their nutriment from inorganic materials of the air and soil. Thus, for instance, under the influence of sunlight plants split up carbonic acid gas, taking up the carbon to form part of their tissues, and giving off the other constituent, oxygen, which is an indispensable support of animal life. On the contrary, animals take in oxygen and give out carbonic acid gas.

The air may be said to be a mixture of gases, vapour, and dust. The gases are oxygen, which exists in the proportion of about one-fifth of the total volume, nitrogen to the extent of about four-fifths, argon to about one-hundredth, carbonic acid gas three-ten-thousandths in purest air, to three-thousandths in that of crowded rooms, and minute amounts of neon, krypton, and xenon. A more exact table of the chief constituents is here given, from which it is seen that nitrogen forms nearly 79 per cent and oxygen nearly 21 per cent by volume of the air, whilst carbonic acid gas exists to the extent of 3 in 10,000 volumes. In ill-ventilated places the oxygen may sink to only 19 per cent, while there may be as much as ·2 per cent of carbonic acid.

The average composition of the air is (Leduc) :—

	Oxygen	Nitrogen	Argon	Carbonic acid
Per cent by weight	23·19	75·46	1·30	0·05
Per cent by volume	20·99	78·04	0·94	0·03

Other components present in variable quantity are vapour of water, sometimes minute amounts of ozone and peroxide of hydrogen, krypton, neon, metargon, ammonia, carburetted hydrogen, and in towns sulphuretted hydrogen, nitrous and nitric oxides or acids, sulphurous and

sulphuric oxides or acids, mineral salts in very small amount. Finally, it contains traces of organic matter, the solid particles of dust being often organic, and having micro-organisms attached to, or contained in, them.

In the Grotto del Cane, near Naples, emanations of carbonic acid gas from the floor of the cave so poison the air, that dogs, which breathe a stratum of air only a few inches above the ground, fall insensible in a few minutes, and die if not taken to fresher air.

Similarly, the valley of the Upas tree in Java, if there is any foundation for this traveller's story, probably owes its influence to an evolution of carbonic acid gas. Readers will perhaps recollect how 146 prisoners were shut up on a sultry night in August in the Black Hole of Calcutta. At 6 o'clock the next morning, when the doors were opened, only twenty-three came out alive.

It is important to beware of the emanations which arise from drains, sewers, and cesspits. Out of twenty-two boys of a school situated at Clapham who watched the opening and cleansing of a drain, twenty were seized within three hours with violent vomiting, diarrhœa, prostration, and fever, and two of the twenty died.

The emanations arising in connection with manure-factories, soap and tallow and chemical works, are undoubtedly deleterious to health.

Remittent, intermittent, bilious, and other malarial fevers and ague are liable to arise near marshes or low-lying badly-drained land.

So far as respiration goes, the nitrogen of the air is generally said to act the part of a diluent. That is, it prevents a too rapid oxidation, which might be very dangerous. Also it should be noted that a method has been found of producing nitric acid from the air. It may even be suggested that it seems not impossible that under certain conditions organisms, and, perhaps, even animals and human beings, may possess, or gain, the power of absorbing some nitrogen from the air. The leguminous plants certainly have this property owing to nodules on their roots, which nodules contain special bacilli endowed with this power.

Birkeland and Eyde have obtained nitrates from the air by electric furnaces at Notodden, near Christiania. According to Sir Wm. Crookes, in the year 1931, if the world's population shall have by then increased to the extent which may be inferred from the present rate of multiplication, the demand for wheat will be that of a quantity capable of being produced, at present rates of yield, by 264 million acres, and the whole earth can only supply 260 million acres of wheat-growing land. Hence, if this be true, the nitrogen got from the air will be a vital need. The so-called lime-nitrogen is, as yet, very expensive. In the meantime, however, probably the leguminous plants will have been effectually used so as to largely increase the stock of nitrogen in the land. By the help of certain bacteria, these plants can utilize the store of nitrogen in the air, and add it to the soil. (*Vide* "Seed and Soil Inoculation for Leguminous Crops," by W. B. Bottomley, M.A., Ph.D.)

It should be noted that outdoor town air is purer than indoor country air. Owing to the very rapid transference and continuous movement

of air by winds, and currents not strong enough to be called winds, the relative amount of oxygen in the air of Seven Dials is the same as that on Ben Nevis, or in the North Sea; but of course there is a very wonderful difference in the quality of the air of such widely different localities. The effects of breathing would be widely contrasted.

The best air is found after rain out of doors, though there is more electricity in dry weather, which causes greater exhilaration in some people. Indoor air never can be other than impure, and where there is poor ventilation, especially if people be crowded thickly, it is very impure. This, unfortunately, is often the case in places of public resort. One should shrink from inhaling air loaded with the impure exhalations of people who crowd the halls, lecture-rooms, and theatres of large towns. It is really better to be out of doors in the towns as much as possible, than to live indoors in the country. Indoor air contains twice as much CO_2 as out-of-door air, as well as the exhalations and débris of the occupants. If a bottle of water be taken into a room and emptied therein, and then a little lime-water be poured in and shaken up, it becomes cloudy, as may be also seen with the air given off by the skin. There may be also inodorous, or smelling sewer-gas, arsenic from the wall-paper, and CO gas. This last gas, called carbonic oxide, results from incomplete combustion of illuminating gas or coal, and it is given off into a room from geysers, unless there be a large pipe to carry it away outside.

Respiration.

In regard to respiration, it may be said that the diaphragmatic kind should be practised, not only by children and men but also by women, and not interfered with, as it often is in the latter, by too tight corsets. When breathing pure air, deep inspiration should be practised; but when one is unavoidably present in a stifling atmosphere, the shallow kind is better. Moreover, the mouth should be closed so as to inspire through the nose, i.e., as a rule, for sometimes breathing through the mouth may be necessitated by the nostrils being blocked, or for other reasons, e.g., when there is a shortage of air. Lower races of mankind, like animals, usually breathe through the nostrils, and some creatures, e.g., the horse, cannot do so through the mouth. The average number of respirations per minute is, in the hippopotamus 1, in the horse and in hybernating animals 10, in human beings 17.

The Skin.

If the skin of the back be touched in two spots two-and-a-quarter inches apart, only one touch is felt, but if the tongue and fingers be tried, always two points are felt, however near they be. Burns and scalds are dangerous mainly in regard to the extent of surface affected, rather than to the depth, because the functions of the skin are so important.

Organs of Speech.

In regard to the organs of speech it may be said that the vocal cords are one-third longer in the male than in the female, that the mouth is

not for inspiration, but for expiration as in speech and singing. By speakers and singers the expiration has to be retarded, and there should be no strain in those processes. Each person has a pitch of voice suitable for himself or herself. It is said that in Russia each member of a chorus sings only one particular note. The articulation should be clear and distinct, and the voice not dropped at the end of a sentence.

Evolution of Light.

The evolution of light from the human body, though exceptional, is, when it occurs, due to oxidation of phosphorus, as in the last stages of phthisis, when the mouth and breath may be luminous. The imperfectly oxidized phosphorus is oxidized, when it comes into contact with the oxygen of the air, and this oxidation shows itself by luminosity. The face is also luminous when phosphoretted oil is injected into the blood-vessels. Also intemperate persons may excrete luminous urine. The alcohol taking up nearly all the available oxygen, the nitrogenous and non-nitrogenous substances are not sufficiently oxidized, until they come into contact with the air. In this connection it may be mentioned briefly that spontaneous combustion of human beings who have been besotted with drink is merely a figment of the imagination, and that the idea probably arose from observing luminosity of the breath in such persons towards the close of life.

Special Precautions for the Old and Feeble.

The old require nutritious food, but not in large amount, either at each meal, or so far as the total consumed is concerned. A very great quantity either at one time, or too much at several different times repeated, making an excessive total, may occasion marked disturbance, and even a fatal issue may result. Variety of food is also an indispensable point, and the fact that this is usually obtained by change of habitat may be one of the reasons of the value attaching to visits away from home-life. If such are undertaken, of course due care must be taken that the change is not one for the worse, or attended by risks. The tenderer meats, such as lean fish, poultry, game, mutton, and the like, are more suitable for the aged than beef, cheese, crabs, lobsters, or the various kinds of shell-fish.

For aged persons the best place of abode is one situated in an elevated position, and preferably on a sandy or gravelly soil, which is thoroughly drained. The rooms should be kept dry, free from damp, warm, and well ventilated. Those who have passed the middle of life, being, perhaps, rather more sensitive to cold than when young, and less able to resist its ill effects, should be protected against cold and wet and also infection from others, especially if any two or all three factors be associated. The feeble and elderly should as a rule avoid being out at night.

Respiratory diseases, such as bronchitis, pneumonia, and pleurisy, are produced by two factors, viz.: (1) Cold; and (2) Pathogenic germs. Fowls, whose normal temperature is 104° F., cannot get anthrax unless their temperature be artificially lowered, as for instance

by making them stand with feet in cold water, until cooled sufficiently for susceptibility. This shows how cold acts in favouring disease, and, as a fact, many human beings take into their pharynx or gullet the germs of pneumonia, but do not get the disease, unless the vital powers are much lowered by chilling.

It is known that most colds are highly infectious. Children, as well as persons who have been attending on pneumonia, bronchitis, or diphtheria, often convey infection—the former, because of their attendance at school, church, or chapel, in close contiguity with others who are ill, or recovering from illness. Even if they are aware of the danger, which is of course usually not the case, they cannot adopt measures of self-protection. Working at fever hospitals and also for the Local Government Board, Dr. D. Astley Gresswell found that diphtheria patients may retain the virus in the throat for a long time. The disease may, or may not, break out again, according as the conditions are favourable, or the reverse, for recrudescence. Whilst carrying the germs in throat and mouth, these patients are obviously liable to infect others.

Adults, on the contrary, generally being aware of the risks connected with crowded assemblies, can adopt precautions, such as disinfection, cleansing mouth and hands after coming away, or even early or at once withdrawing themselves, if the atmosphere be unduly close and bad, whereas children do not know such steps are necessary, and even if they did know, would often probably not carry them out, being afraid, prohibited, or unwilling to do so. Many a child's life has been lost by infection caught in such a way, or even in some cases by that resulting from their own parents and attendants, who can carry the germs of disease without themselves ostensibly suffering therefrom. No doubt there are conditions in which one may be really affected by a disease without showing any obvious signs. Sometimes children's restlessness may be due mainly to natural peevishness or querulousness, perhaps ; but, on the other hand, a child's instinct that something is wrong may cause such uneasiness, and, indeed, be unerringly true. Hence, it would often be better to interpret it as signifying a real need for withdrawal from a dangerous risk. If treated with angry reproof and unwise correction, perhaps its natural instinct may become repressed, for it is easy to detect a foul atmosphere when first submitted to it, but soon the senses become dulled as one gets used to it, although the harm resulting is probably by no means lessened. It is deplorable, but only too true, that children are often very foolishly treated, and subjected to needless risks, when they would have far more wisdom in some respects than their guardians, if left to obey their own instincts regarding self-preservation.

Visitors to the sick, and those brought into relation with them, should, before eating or going amongst other people, gargle the throat and wash the mouth with a solution of permanganate of potassium (about ¼ gr. or so to the ounce), or other weak antiseptic, such as a solution of common salt or alum, or of perchloride of mercury made of one part of liquor hydrargyri perchloridi to eight of water, in addition

to the adoption of ordinary measures of cleanliness. These habits are not only useful for oneself, but also materially lessen the risk of conveying infection to other persons, whether young or old. Especially the young, the weak, and the old are liable to take infection easily ; and many a parent unwittingly introduces into his or her own household the very maladies that should be guarded against most carefully. Again, protection from infection by dust is very important, and in this respect motor-cars are not salubrious, especially in hot weather and in crowded places, for those who are submitted to the clouds of dust they leave in their wake. Special tracks should, where possible, be made.

Severe spells of cold weather are dangerous for the aged—and also for the very young and the weak. At such times it is particularly necessary that the clothing should be warm and comfortable, and, next to the skin, rather thick material should be worn, and changed once or twice a week. Even two or three jerseys may be worn, and serve better to retain heat than overcoats do. Moreover, the rooms should be kept at a proper and equable temperature. Sir Lauder Brunton writes that the old should be careful in the passages and on the staircases of a house, and in regard to the w.c., where the air is apt to be dangerously cold, and also that care should be taken as to draughts. As may easily be felt by the hand, there is in a room a draught between the door and the fireplace, and hence a chair should not be placed directly in front of the latter, but at a little distance laterally from it, and as a further precaution to avoid this draught, which is strongest near the floor, a rather high footstool should be at hand for the feet of the weak and the aged. This will also assist the circulation by lessening the tendency to downward congestion of inferiorly situated blood-vessels.

Some people seem to think that ordinary colds are not of much importance, and that they may expect to have one at least, if not a few, in the year. This is a very great mistake. Not only may death easily spring from a severe cold taken, so to say, on the top of a slight one ; but there are also many evils connected with even the least severe attacks. For instance, sometimes the heart may be affected, or the nervous system, as well as the more obviously implicated structures. Again, from sore throats and colds in the heads, the inflammation may extend by the channel of the Eustachian tubes even to the middle-ear. Deafness, indeed, is by no means an uncommon complication of a cold, and the writers have frequently used a means of cure by introduction of variously medicated vapours along the Eustachian tubes, which has been very successful.* A good test of the power of the hearing is to find if any ordinary watch can be heard ticking at a distance of about a foot from the ear. If so, it is not very defective.

Similarly, if a book be held for reading less than a foot from the eye the eyesight is defective.

The mental faculties are frequently very vigorous in old people.

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* *Vide Dublin Journal of Medical Science*, July, 1906.

However, it is wise that moderation should be used in the putting forth of this vigour, and that there should be as little stress as possible, for the aged should enjoy mental quietude. Anxiety should be avoided or repressed, and one should cultivate cheerfulness and tranquillity of mind. The food should be well selected and carefully regulated in accordance with the special needs of the system. Wines or other stimulants should be used only in strict moderation. The exercise taken should be sufficient, but not such as to produce fatigue.

The muscular fibres of the voluntary muscles, as well as those of the heart and arteries, are liable to undergo degeneration in the old, and these therefore experience difficulty in active movements, and especially in running, or climbing a height out of doors, or a staircase in the house. The feebleness of the circulation may produce a chilliness of the extremities. It may at times even be a wise precaution for such persons to remain indoors at first when there is exceptionally severe weather, protected by the warmth of fires, or hot air, or hot-water pipes—at any rate until they are able to go out with safety, after having become used to the change. The stock of power and energy, being small, must be prudently maintained.

At least, then, during the evenings, and in some cases, as when feeling very weak, or in inclement, windy, cold, and wet weather, during the whole day, the aged should, wchn necessary, remain indoors in rooms kept at about 60° F., and in the bedrooms also the same temperature should be maintained. At any rate in very cold weather, the sleeping apartments also should be at once warmed and ventilated by means of a coal fire. An open fireplace and chimney are most beneficial, and the latter should never be stopped up, since, even without a fire, it serves as a ventilating channel. The clothing, too, should be warmer in colder weather. Care should be taken to maintain the heat of the body by more frequent feeding if necessary, and the legs and feet especially should be kept warm by extra warm socks and boots. Infection of every kind should be particularly avoided. Scrupulous cleanliness is requisite at all ages. Save when the constitution is very weak indeed, bathing should not be forbidden for the aged ; but, of course, great care is necessary, whatever be the mode of cleaning adopted. It is true that cleanliness is far more necessary for the old than for the young, and possible that if a warm foot-bath were taken every night, and the toe-nails cleaned and clipped regularly, some distressing cases of gangrene of the toes and feet might be obviated. However, gangrene no doubt results from a very great diminution of vitality—and, probably, a definite kind of germ.

Obesity.

Some people, especially at about middle age, are apt to become obese. The fat may be in such amount as to be burdensome, and if it greatly accumulates about or within vital organs, such as the heart, liver, or kidneys, may lead to a premature death. Sometimes it is gathered in the mesentery, whereby a prominent or pendulous abdomen may be

produced. In order to obviate further deposit of fat, regular exercise should be taken, and the diet be modified, so that exercise can be taken more freely. Fatty matters, milk, butter, cheese, sugars, starches, pastry, puddings, rice, flour of various kinds, potatoes, spirits, beer, stout, should be diminished, the food consisting of lean meat, green vegetables, salads, and wholemeal bread. Soda or potash waters may be taken, and vinegar may be moderately used. Vapour baths may in some cases be cautiously tried. If there be constipation, laxative food, together with occasional enemata, or suppositories, with mild aperients if necessary, may be suggested ; but such measures, and especially all medicines taken, should be prescribed and, so far as possible, their action supervised, by a medical man. Costiveness may often be due to loss of vigour in the muscular tissues of the bowels and the abdominal walls, and it is therefore best remedied by strengthening and regularizing the whole bodily fabric.

Diseases of metabolism, such as gout, diabetes, and adiposity, are related to one another, there being an insufficient power in the organism to transform definite substances. In diabetes there is lack of power to transform sugar, whilst in adiposity fat is not transformed, and in gout, uric acid. There is insufficient oxidation in these diseases. Women may become obese after the climacteric, and after removal of the ovaries. If ovarian extract be given to spayed animals, the slow metabolism of fat will be augmented, as also in women after the menopause. Thyroidin causes anæmia and nervous disorder, leading to oxidation of albumin as well as of fat. Boric acid is another remedy—less hazardous, but not highly efficient.

The albumin in the food must not be diminished; the amount of fat must be reduced, but not the carbohydrates. The quantity of water need only be restricted in grave cardiac trouble, and any amount may usually be taken by the obese. Diminution of water may lead to calculus of the gall-bladder and kidney, the tissues of the obese being already poorly supplied with water. Prof. P. F. Richter, whose views we are following, advises :—

1. Albumin, as usual, about 100 grams daily.
2. No fat, butter, milk, cream, or sauces.
3. Potatoes and vegetables, which contain carbohydrates, but are poor in fat and calorics. For dinner five to six potatoes (200 grams), and 150 grams in the evening. Vegetables which contain much cellulose, like radishes, are allowed at tea-time.
4. As much drink, especially mineral water, as desired, but no alcohol. Ten minutes before a meal a drink of mineral water is allowed. Thereby satisfaction is increased.

By the above diet weight is reduced ; but there is no loss of albumin.

In the treatment of obese patients the baths and waters at Marienbad are valuable.

CHAPTER V.

PAIN.

ANY neglect or infringement of the correct ordering of life is liable to be accompanied or followed by the feeling of pain. This sensation may be looked upon from exactly opposite points of view, viz., either as harmful, or on the other hand as likely to be attended with, or followed by, beneficial accompaniments or results. If any part of an organism is damaged, pain is usually felt, and the severity is directly proportionate to the degree of advancement in regard to structural development. In many cases pain may be salutary. Without the warnings supplied by it, according to Max Nordau, we should be unable to guard against dangerous symptoms. Undoubtedly an insensibility to pain is a grave condition. On the other hand, there are some relatively minor disorders, for example some kinds of neuralgia, which occasion severe agony. The pain arising from a bad tooth may be almost intolerable, and the pains accompanying child-birth are sometimes very great indeed, and yet in neither of these cases is the condition usually so grave as it may be in certain kinds of cancer or kidney disease, both of which may exist for some time in some cases without much, or even any, pain.

The skin is richly endowed with means for appreciating pain. It is highly sensitive, and this no doubt is advantageous, because it causes an animal or human being to rapidly withdraw from influences which will damage, if not guarded against. The interior of the body is not so highly sensitive, and it is a strange fact that one can swallow hot fluids without much discomfort, which one could not bear on the skin of the hand. In this connection the Plombières treatment, now carried out also at Harrogate, is noteworthy. The principle is the washing out of the colon by hot enemata; but one cannot advise this treatment for many, as it seems too severe in some cases. Putting aside nerves and nervous tissue, which, of course, are sensitive, one does not feel so much pain if the muscles or tissues or organs be injured, as if the skin be. The sensibility is most marked superficially, and it is said that a horse pricked by a bayonet point will thrust itself on the blade, apparently with the view of pushing it away, not feeling apparently so much pain internally. However, the action may partly be explained as due to loss of sense caused by excitement and panic.

In regard to the factors which produce or evoke disagreeable feelings, they may not be always of a highly destructive kind, nor really definite lesions which can be detected. No doubt, there must be some disintegration of tissue at least; but in many cases it may be imperceptible by

known methods of research, and apparently so minute as to be capable of ready repair. Yet, at the same time, the pain felt may be most severe. Even slight pain should never be lightly regarded, but looked upon as a warning that something is wrong—that there is some disturbance needing relief—that there is some damage to some of the ultimate elements of tissues, causing diminution of elasticity, and consequent perversion of normal functional changes. In some cases the injury may be mechanical, but in others may be the effect of some kind of poisonous substance, organic or mineral—in the latter case, ingested into the system ; in the former sometimes also ingested, but more frequently produced by changes therein. In very many cases, and to a very large extent, the cause of the irritation may be either removed or antagonized.

One person may shriek, or scream, when suffering pain which another might bear without a groan or a murmur. It is not merely a difference in sensitivity, but also a question of fortitude. The psychology of the sounds is very intricate, as also is that of tears. Doubtless, the ancients, in their use of tear-bottles* ("Put thou my tears into thy bottle"), understood the meaning and the value of weeping far better than we moderns comprehend it, just as were known at various times in history many other most valuable facts, of which we now are not cognisant. In the Temple of Cos, where Hippocrates carried out his wonderful cures, there were couches laid out for patients to recline upon, so as to receive ozone-laden breezes of the sea and shaded rays of the sun—the modern fresh-air cure.

Groaning and gnashing of teeth are spoken of as concomitants of the acutest sufferings imaginable. They are both forms of activity. Groaning may be considered from the point of view of the sufferer, informing himself, so to speak, through the ears of the urgent need for precautionary measures to obviate the poignancy of the pain. The brain being informed, acts so as to lessen the shock of the receipt of the nervous impulses, and, where possible, directs other things to be done to diminish the suffering. It also acts by attracting help from others ; but a human being will receive a certain amount of help to bear pain by groaning—even when in entire seclusion, and when there is no question of receiving outside assistance. Gnashing of teeth is not so very commonly seen in sufferers, and both gnashing and grinding of teeth seem to be concomitants of intense thought, rather than of pain. However, any intense form of action, whether mental or physical, is apt to be accompanied by at least a certain amount of discomfort, if not of such as can be called pain. Sometimes pain, or rather suffering, becomes so great, that the living being can scarcely endure it. Sometimes, for instance on board ship, one's condition may become so full of bodily distress, that one would scarcely mind if the ship went down. Sea-sickness is probably due to some disturbance in the equilibrium

* Vide article by Dr. A. Gresswell in "The Louth Advertiser," Feb. 23, 1907, in which he states that "tear-bottles" were certainly used by ancient peoples for the relief of pent-up feelings, the weeping being no doubt purposely induced.

of the cerebral fluid, perhaps also of the semicircular canals of the ear, perhaps of succussion of other fluids in the body, such as that in the stomach and bowels.

Headache, too, may cause the most acute suffering. It may sometimes usher in an attack of influenza or other fever, being then at least partly caused by an accumulation of mucus in the frontal and nasal sinuses, the rationale of this last being that it is probably protective, i.e., that the secretion is produced by the multiplication of cells formed to destroy the micrococci of that disease, and so prevent more dangerous complications, such as pneumonia.

Now, when we further consider this complex subject of pain, the most important point is to be on our guard at the outset, and throughout the discussion, and bear in mind that we are not dealing with a definite factor, but with one presenting every conceivable kind of variety and degree. So diverse is the picture, indeed, and so kaleidoscopic in change, that it would almost seem an impossibility to lay down general rules regarding it, or to explain it on any fixed philosophical plan or theory or basis. Hence arises the confusion of thought regarding this subject, for what is true of certain kinds of pain is by no means true of all. For example, it is quite true to say that several causes of pain are sufficient to cause activity and struggling, but one must remember that the effect varies, firstly in regard to the degree of pain, and secondly in regard to its cause, and thirdly in regard to the individual experiencing it. It is well known that in battle serious injuries may be received, and the excitement be so intense that little or no pain is felt. If so, the wounded soldier may go on fighting, until after a time the effects of the wound compel cessation of further struggling. It is the same in ordinary fighting, and also in the minor accidents of life. As a rule, there is not much pain at the time of actual receipt of injury, because the mind is perhaps either unduly excited or, on the other hand, benumbed. Painful feelings come on subsequently, and perhaps after a *mêlée* or a football match, or a fall from a bicycle or horse or trap, the injured person may on the morrow feel pain and see bruises, of which there has been little or no previous consciousness. Hence it may in many instances be rather the case that the sufferer is spurred, by the receipt of an injury, to activity, than that actual *pain* stimulates to work. Then, again, the result depends entirely upon the extent of the injury, because, if it be very great, absolute inability may be produced; just as, too, the pain, albeit often in abeyance, as above pointed out, during the excitement of fighting or fright, may in other cases be so great as to cause paralysis. To sum up, it would seem that, just as pain is felt in various kinds and degrees of severity, so it may occasion various kinds and degrees of activity or rest. Indeed, it may apparently excite one or other, neither, or both. That is, it may produce activity of one set of organs, and rest of others, and so forth.

With this proviso borne in mind, it is still a general rule that pain stimulates to some kind of activity as a primary result of its action,

though the activity produced may not be continued for long, and may be followed by rest at even an early subsequent period.

Here we should note two points, firstly, that the excitement and the terror of a severe accident may almost annul the power to perceive pain, just as that extraordinary exultation which is felt in combat does. Hence it would be more correct to say that the highly-strung feelings of zeal, excitement, and enthusiasm stimulate renewed exertions, than to maintain that pain does so. As is well known, many persons take a positive delight in any kind of physical activity, and especially in that connected with the chase or fighting. After a hard day's shooting, or one in the hunting field, one may feel fatigued next day; but the joy experienced during the whole time of activity may dispel all feelings of exhaustion.

The other point is, that the amount of pain felt bears no constant relation to the amount of injury received, and one may feel as much pain from a prick as from a far more severe accident. Again, some parts are especially sensitive; and again, some persons can bear what others cannot; and again, the brain seems to get the power to endure pain on becoming accustomed to it. For example, the traveller, Mr. Catlin, visited in 1834 a small tribe called the Mandans, consisting of about 2000 souls, who lived in two villages on the great river Missouri, 1800 miles above its junction with the Mississippi, and stated that these hardy warriors gained the power, by training, of bearing nearly all forms of torture.

Similarly, it is well known that, one tooth having been drawn, the extraction of another is not usually so painful an operation. The nerve-centres in the brain may be partly dulled, though if the two teeth be in apposition the force required for withdrawal is of course less.

Indeed, it is very likely true that the reason why so many deaths have occurred during tooth-extraction under anæsthetics is, because the brain, receiving a near, sudden, and strong shock when benumbed, is far more vulnerable than when it is actively at work. No doubt the will-power can to some extent withstand the effects of shock.

On this idea the suggestion often inaccurately made, "It will not hurt you," should be modified to the more truthful one—"There will be some unavoidable pain, but your brain can resist the feeling of it." In the Japanese War anæsthetics were not very universally used, and still the fatalities after operations were not so very great. However, few races are so stoical and brave, and one cannot, therefore, advise any better rule than that there should be a judicious selection of cases in which local, general, or spinal anæsthetics ought to be used. For dental operations especially, and for most minor operations, local anæsthetics such as the hypodermic use of eucaine or tropacocaine seem best adapted.

Frequently pain at its outset incites a living being to measures which subserve self-preservation, but at the same time it must of course do some harm. If the petals of the sensitive plant are touched, the corolla will partially close. If a frog's toe be placed in an acid, the leg

will instantly contract, and remove the toe from the corrosive. If the foot of a rat be placed in a weak solution of atropine, the pupil of the eye will soon dilate, the atropine being absorbed into the blood, and producing its usual effect. In the general way it may be noted that, in consequence of unpleasant and damaging sensations, an animal attempts to remove itself with all speed from the supposed source of injury, or to dislodge the cause of pain. Or if there be fear of danger or suffering, the apprehension occasions a similar result, as also if there be hunger, thirst, or some other pressing need, such as that craving for salt which is experienced by all animals alike, strenuous efforts will be put forth in order to satisfy the want. In short, any cause of suffering, whether positive or negative, will be a spring of action, and might also be observed and studied as a clue to the character and degree of the activity evoked. The pain caused by fighting with competitors for food is of advantage, in so far as it leads to strenuous attempts to overcome the antagonist. Now, if we look upon the rationale of pain from this point of view, it seems quite obvious that those animals would best be able to survive, who were most unpleasantly affected by a deficient supply of food or water, or by, for example, the entry of irritants into the digestive tract, or by the sustaining of injuries, in such way that they would adequately respond with the view of overcoming the disagreeable feelings engendered in each case, i.e., to gain food or water, to eject the irritant, to make effective escape or successful combat. There are, it is true, several kinds of pain, for which we cannot easily find any possible satisfactory explanation. For instance, toothache, as was above said, is doubtless often very agonizing, and indeed it is also most harmful, and causes very marked depression and inability of mental application. It is not very obvious that any good purpose can be served by such pain. It would be too great a strain on the imaginative faculty to hold that toothache was evolved as a necessary spur to the inventive faculty of man, so that he should be incited to the discovery of modes of, and the manufacture of instruments for, extracting teeth. That would be too obvious a substitution of the correct placing of cart and horse. Regarded perhaps as a means of curbing excess in eating, by causing a diminution of the ingestion of hard food or flesh, the decay and resulting pain ensuing therefrom may seem to have a meaning. In addition to toothache, and more efficiently than it, there are of course other forms of pain, such as that of the stomach and bowels, as well as heartburn, which would tend to prevent excess of food being taken. Hence, it is not easy to accept the idea of the usefulness of toothache in regard to overeating as entirely satisfactory.

Again, it is manifest that, whilst sensitivity is on the whole perhaps useful and advantageous, still, when it is too great, an indulgence in luxury is apt to be engendered, and this in its turn is exceedingly enervating. Hence, clearly pain acts in two different ways—for good and also for bad. A balanced judgment should be taken in regard to all forms of it, and in considering even such distasteful and unpopular

subjects as that of "tramping," one may perhaps do well not altogether to dismiss the notion that the hardihood, produced by exposure to stress of weather, may not be entirely without advantage to the human race at a time when a too close observance of comfort acts as a weakening influence. Most abuses have some compensation, and thus we may mention that even the wandering vagrants, little as we may admire their habits, may, by their example of the possibility of becoming inured to bad weather, be not altogether wasted in nature's scheme. Much more applicable, save in one respect, is this argument to the sailors and soldiers, who, by their hardihood and bravery, exemplify the benefits which undoubtedly accrue from exercising the virtues of courage and endurance. The one point in which the case is not so potent as an argument is that of their being under rules and restraints imposed by their officers, but to a large extent the lack of freedom is more than compensated by good management and guidance. However, one sees in the tents and bungalows on the seashore full freedom of choice usually coupled with the best results, and this habit serves as a good instance of the healthy aims of the people of the day.

Now we come to a point of much interest, viz., that in an active animal afflicted with pain, on the first onset thereof, we may often find the manifestation of those functions which are produced by an animal setting to work. The first result of injury is an attempt to obviate its cause, and this entails activity. Afterwards, sooner or later as the case may be, these phenomena are apt to be replaced by those of rest, especially if there be exhaustion. Still, the point we now note is that the first consequence is an attempt at an effectual kind of activity, and this in the physiological sphere is shown by various signs.

The heart's action is increased, as also is that of those muscles which, likewise in fighting, would be more or less directly concerned. Even the muscles of the ears, eyes, and lips may be in some degree brought into action. Similarly, when an animal is undergoing pain, there are exhibited more or less intense excitement, perspiration, and perhaps screaming. Hence these associated functions concur in animals, including man, not only when they are consciously and suitably directed to the removal of a pain-giving agent, but also when the pain cannot be thus removed, being due, as in disease, to causes of quite a different nature. In the former case the reactions are directed to measures of self-preservation, leading as they do to redoubled efforts at defence ; while in the latter case they may be not only beneficial, but of a very harmful and even fatal character. When the pain results from morbid processes, the harm done by the reactions of the organisms is oftentimes excessive, while the benefit is reduced to a minimum, or there may really be no advantage whatsoever. Thus, as in the case of ordinary physiological processes, so also in those which are called abnormal, certain remnants of "antique customs" still remain to clog the wheels of more highly developed processes. Just as certain rudimentary structures, not only useless but even harmful, remain in higher animals to interfere with the working of

newly-constituted organs, so, too, organisms may be said to make, now and again, great and sometimes even fatal mistakes, in the processes by which they attempt to throw off the results of injuries, or to atone for damaging changes. The conditions, though appearing similar, are really different, and hence the ordinary reaction, when put forth, cannot be a successful one. In an acute attack of gout, the manifestations of the febrile disturbance, which is supposed to be secondary to the joint affections, are acute pain, rapid pulse, some rise of temperature, perspiration, great restlessness and excitement, and possibly screaming. Further, it is a most noteworthy fact that the pulse of an animal suffering from pain is almost invariably accelerated, and the beat itself is also strong in character. Restlessness and vigorous action of the muscles are likewise manifested by animals which are in pain.

The leg of a frog contracts when the toes are irritated by an acid or in other ways. Indeed, that movement accompanies the infliction of pain is well known. We are, in fact, so accustomed to the invariable connection which subsists between these two vital manifestations, pain and movement, that we are in the habit of inferring the presence or absence of pain, according as we do or do not observe its correlative signs. Indeed, it is quite possible we may sometimes be mistaken, for, on the one hand, a cry of seeming anguish may not in all cases denote pain, while, on the other, the absence of signs of pain, as in calm resignation, may not be inconsistent with great suffering.

Speaking generally, however, we find that groaning, screaming, perhaps sobbing and weeping, grinding of the teeth, clenching of the hands, and violent paroxysms of convulsive movements, are seen in most of the higher animals when suffering pain, and it seems that these and the like phenomena can be ascribed to their association in the past with pain resulting from direct struggles with a foe. In fighting, all the muscles and organs of the body receive an intense impetus. The animal is quick to see in advance the tactics likely to be used by the opponent. The heart must be accelerated, in order that supplies of blood may be sent to any and every portion of the body. The eyes and ears also must be more sharp than usual, and hence the muscles connected with these sense-organs must be on the alert, and ready to set them to the best advantage for hearing and seeing, and also to protect them, or at least the eyes, from injuries, as far as possible. In short, nearly all the muscles of the body are liable to be called into action. The wild and piercing cries uttered by a creature almost worsted in the deadly strife, as they re-echo far and wide, may avert a threatened defeat by frightening the antagonist perhaps, or at any rate by attracting comrades to help. Groaning and cries of distress are also helpful as brain-stimulants, as before mentioned. Again, the quickened action of the heart raises the body temperature as a whole, since it leads to quicker oxidation, and probably in many cases at least to the manufacture of antitoxins. In pain, likewise, the temperature often rises measurably, and it falls when, as by the influence of morphine or otherwise, the suffering is subdued. In this relation it is

well to bear in mind that peripheral increase of heat may occur, though the oral temperature be not altered. The augmented action of muscles and organs gives rise to an increased amount of waste products. It is not at all correct to say that there is, during pain and during excitement, always an additional sensibility to cold; but undoubtedly the factor of cold adds greatly to the depression consequent upon those conditions. When sensory nerves are strongly irritated, or there is mental excitement, or pain, the pupils as a rule undergo dilatation. They also frequently dilate in cases of locomotor ataxy, though generally contracted in this disease, when an attack of pain occurs. On the other hand, when the cerebral centres of sensation are dulled, as in opium-stupor, they contract, though they dilate under the influence of belladonna. In sleep the pupils contract, and the eyeballs turn upwards. They are also contracted in the stupor of typhus and typhoid fever, and also in that of relapsing fever, as well as in the anæsthesia produced by chloroform, notwithstanding that, in the stage of profound narcosis which supervenes, they dilate. Some animals—for instance, the cat, when preparing for action or defence, as upon the approach of a strange dog—at once show dilatation of the pupil; and also in human beings the pupil dilates, if the sensory nerves be strongly irritated by pain, or as a result of excitement, or during severe muscular exertion. The endocarditis of chronic Bright's disease is attributed to the extra blood-pressure, which, indeed, is one of the earliest manifestations of inflammation of the kidney. Hence, the value of the subjugation of pain in cases of endocarditis and of the pericarditis of rheumatic fever may be to some extent due to the coincident soothing of the heart. We see, then, that the occurrence of pain, due to whatsoever cause, arouses the associates of work, not only in health, but also in disease, though, of course, we must not forget that the sufferer may become exhausted, and therefore no longer able to manifest the processes referred to. Now, the constitutional unrest, which is set up by the pain consequent upon an injury, must and does work harm. If the skin be irritated, but little discrimination is made between sensations which call for action and those which call for rest. Moreover, pain in a limb, in the head or neck, or in the skin, may even give rise to such general unrest as even results in death, the unrest being, in the case of pain on the surface, probably that of alertness in the fight, or for flight, the idea being that there may be an external cause or source of pain to be resisted or escaped from. An animal or man at work, or getting ready for work, shows contraction of muscles, quickened heart-action, and respirations, elevation of temperature, increased peristalsis of bowels, dilatation of pupils, and augmented action of the skin. If either itching or other kind of discomfort be occasioned, an animal will scratch, bite, kick, or, perhaps, gently or forcibly rub the irritated part, so as if possible to remove the irritant. Similarly, an animal, experiencing painful sensations springing from internal causes, may bite or kick energetically at the part of the body which apparently is related, by the channel of the nervous supply, with the affected structure or organ.

Likewise, as is well known, relief is felt from the application of one or more leeches, or a small blister, to a portion of the surface of the body which feels tender or painful, in correspondence with inflammation or other affection of an internal structure or organ. Again, if the conjunctiva be irritated, the eyelids will contract; if the nasal mucous membrane, sneezing is evoked; if the throat, attempts to swallow are caused; if the rectum, straining results. All these reactions are good, conservative, and suitable, as a rule, since they are such as tend to cause the removal of the irritant. Yet similar reactions are shown, even when the irritation has brought on inflammation, and also when the latter condition has been produced by other causes than externally applied irritants, and when harm may be thereby produced. The result may then be a damaging one. Again, if a nauseous and irritating substance be swallowed, vomiting may ensue. In fact, if an irritant be present in any portion of the digestive tract, either vomiting, or defæcation, or both, may occur. Now, in most instances, there is no doubt that it is best that substances which are nauseous or irritating should be thus rejected. Still, this reflex vomiting and diarrhœa also persist under pathological conditions, when they work harmfully by causing weakness, and perhaps even a fatal issue. When an injurious substance has been swallowed, vomiting and diarrhœa, either or both, may be useful; but not in cases when it cannot be thereby removed.

For example, if a corrosive acid in small bulk has been swallowed, the lining membrane of the stomach will be at once acted upon, and vomiting will not be capable of ejecting it. On the other hand, the effort is positively one full of danger, because the walls of the stomach, which are set violently in action, are already so damaged as to make contraction not only painful but highly injurious. There will be more harm still if, in addition, diarrhœa be provoked, and also no advantage, because it, too, cannot be an effectual mode of evacuation. An ulcer of the stomach or bowels is an exceedingly painful affection at times, and it sometimes causes the very result which should be avoided, viz., vomiting. This is a reaction which we attempt to obviate by every means in our power. It is one of nature's inexorable ways—on the kill or cure system. Apparently, it is, so to speak, a kind of mistake on nature's part, and intended to remove an irritant. No doubt, there is great irritation; but, unfortunately, it is due to a cause which cannot be ejected. Hence, vomiting is not only bound to be futile, but also very likely to be destructive.

So alive, indeed, are the intestines to the reflex effect caused by irritation, that vomiting may occur in enteritis, or owing to compression of a portion of intestine by its being gripped as in a hernia. Vomiting may also occur if structures in close relation with the intestines are injured—for instance, in peritonitis, in compression of a mesentery in a hernia, in biliary colic, and also when tenesmus is excited by irritation and inflammation of the lower part of the intestines, and even in irritation of the fauces. In many of these cases the reflex effect is productive

of harm. There is reason to believe that the irritation of the throat is partly a cause of the vomiting which occurs at an early stage in cases of scarlet fever ; and since vomiting also occurs at the onset of diphtheria, and small-pox, in which the fauces are attacked, and likewise closely follows the onset of inflammation of the fauces, it seems as if in all these cases the irritation is the cause of vomiting. Similarly, violent coughing may bring on retching, which is apparently due to the irritation of a pellet of mucus which has been coughed up into the throat. Conditions which give rise to pain, or to sensations of discomfort, may be hurtful, and also produce other phenomena, which, when prolonged, are likewise injurious. A mechanism is evoked which is beneficial in cases of pain resulting from slight and readily-healed lesions, and even the anticipation of these may call it into action ; whilst in cases of severe pain arising from causes, incapable apparently of being so benefited, it is, nevertheless, still set going, and may even occasion the death of the individual manifesting it. The same mechanism will operate when the struggle is over, if lesions have been sustained ; for the effect of these being still operative, seems to be a confusion, so to say, in the nervous system of the animal, which acts as if the original cause of the lesion were still at work. It seems in short as if mechanisms of nervous action were set going by disagreeable sensations, whether these sensations were produced by injury, or by a disease occasioning a similar feeling of pain.

The rough handling of a nervous horse may cause palpitation audible at a distance, and irregularity, intermittence, or even a longer cessation of the beat. In the case of man, convalescing patients exhibit most markedly oscillations of temperature as consequences of excitement. On the other hand, a rise of external temperature, as when entering the tropics, occasions elevation of temperature of body, acceleration of pulse, diarrhœa, perspiration. The diarrhœa may be partly due to micro-organisms in some cases, but also to increased action of the muscular coat of the bowels, and also to augmented activity of the liver. Similarly nicotine produces quickened action of the heart, dilatation of the pupil (though contraction if applied directly to the eye), slight perspiration, and perhaps movement of the bowels. Perhaps there is some nerve-mechanism, which controls all these associated functions, and which is acted on. Again, in exophthalmic goitre we see a similar set of symptoms. Slight local pain causes contraction of muscle, and more and more contraction as the pain increases. Also there are : rise of temperature, increased activity of perspiration, acceleration of the heart, dilatation of the pupils.

Now diseases cannot be regarded as beneficent, even so far as communities are concerned, for they work immense havoc at times, and do not attack merely the weak alone. Indeed, neither pestilence nor war can be said to eliminate the unfit only, for, on the contrary, it is often the strongest, healthiest, and best that are thereby killed. Survival of the fittest—especially in these modern days of indiscriminate slaughter in fighting—does not really hold in regard to warfare at all, nor does it

in regard to disease. Immunity is not by any means the same quality as strength.

Moreover, it is only a partial truth, and not by any means universal, that the symptoms of disease are the expression of natural efforts for a cure. In fact, the reverse would seem sometimes to be nearer the truth.

It cannot, indeed, be held that nature's plans are altogether conservative, for in cases of peritonitis the vomiting may be so extreme as of itself to bring on a fatal issue by exhaustion, and this even when there is no question of any irritant which, if present, might possibly thereby be in some measure got rid of. Hence, although the intense pain and discomfort of peritonitis might be serviceable in causing desire for rest, in so far as it does really secure that need, they are really exceedingly injurious, inasmuch as they also evoke continued vomiting. Another example of a similar seemingly erroneous adjustment of a natural process is seen in the case of the pain caused by the passage of a gall-stone or a renal calculus. In both cases the great pain causes a living being to seek rest, and also to vomit in a distressing manner. It is just possible that the vomiting, as also in the case of the onset of acute fevers, and also in cases of tubercular meningitis, may be partially explained as being an attempt at elimination of various matters (urinary products in the case of the renal calculus) ; but it is evident that this is not the chief cause or rationale, but that the vomiting is really a case of unsuccessful adjustment of function, i.e., to an apparent, rather than an actual, need. It is, so to speak, as a rule in these cases, a mistake —and also a damaging one.

Another idea about pain is that after a time it tends to become less strongly felt. In other words, a cause which evokes pain in the first instance may cease to produce that feeling. The nervous structures involved in the sensation of the pain may become blunted, and fail to receive the disturbing influences. In this way danger may arise, for an animal may be thus led to incur a risk which is dangerous, and may be fatal.

1. With reference to pain occurring in superficial parts, it is noticeable that it occasions greater readiness for action, but not as a rule vomiting.

2. If there be pain in the course of the digestive tract, a special tendency to vomiting and collapse is seen. Suddenly occurring gastric pain causes dilatation of the pupils with slowing and strengthening of the heart's action, and general disturbance of the system is marked, as it also is in cases where there is enteric pain.

3. If the pain be caused by disturbance of intermediate parts, both excitement and vomiting occur.

In each of the three above cases, the same, or very similar, results in less degree may be occasioned by anticipations of pains in those particular places.

Now, it is obvious that the extreme sensitiveness of the skin which ensures great pain in injury to superficial parts, and also the recognition of this pronounced liability, are advantageous, inasmuch as they evoke great efforts to escape from a source of injury, to remove a cause of

irritation, besides inducing subsequently a desire for rest and an inability for exertion. It acts, indeed, in two opposite ways, first stimulating, until the source of danger is removed, or the animal be exhausted, and then afterwards in either case the reaction comes, and rest is brought about. Further action would obviously augment the pain, and therefore the animal refrains from activity. If, however, the reaction do not come, and the excitement be continued, the unrest caused by excessive pain may be damaging and even fatal. In fact, it would appear that the mechanisms of nervous activity are rather adapted for health than for disease, nature having perhaps but little interest in damaged constitutions. Hence, in diseased conditions, it often happens that the rest which is necessary for a cure can only be obtained by the aid of drugs and other therapeutic measures. Unfortunately it would seem that nature has not provided herself with a special mechanism of action suited to affections of the peritoneum, but, so to speak, uses the same mechanism as that employed for disorders of the digestive tract. One might almost be led to suppose that the chief mechanism of reaction for all disordered states is at least associated with that adapted for fighting, escaping, and feeding. The problem is a confusing one ; but, in conclusion, it may be repeated that pain resulting from injury is certainly beneficial in evoking renewed efforts to obviate a cause of injury, and if success be gained in this respect, in afterwards inducing rest. It is, however, harmful, by causing continued excitement if the pain be continued, and this is more especially the case if the pain result from morbid processes. Again, inflammation is highly beneficial, if successful and not too prolonged ; but is damaging if the heightened temperature resulting be too protracted.

Moreover, alternations of work and rest are in correspondence in the natural state to the alternations of day and night, the months and the seasons. To a large extent civilized human beings adhere fairly well to the periodicity which partly compels work to be done by day and rest to be taken at night. No doubt we suffer, too, by partial neglect of this dictate of nature, and have become in consequence weaker, in so far as we transgress that law. The other alternations also are nowadays, so far as possible, largely ignored ; but, nevertheless, they also play a very great and striking part in the great drama of life.

Chapter VI.

CONDUCT AND MODERATION.

Conduct.

Although some problems, such as the meaning and use of evil, and especially those aspects of it which are most destructive of good, appear almost unintelligible, still the phenomena of Nature are as a rule the more simple, the more we regard them in the aggregate. For example, many ideas, suggestions of theories, and inferences may be drawn from observing the conduct of animals, and some of these, when suitably modified, can be applied to mankind.

Human beings cannot be held responsible for their own existence, and yet they must be thought to be responsible for their conduct. Indeed, such responsibility is often unquestioningly admitted. The doctrine of free-will may be laid down as at least partly true before formulating rules of ethics. Clearly it would be absurd to state that such and such impulses, ideas, beliefs, considerations, should influence actions, unless some freedom of choice were assumed. The other supposition, viz., that a human being is merely an automaton, directed either by a blindly-working energy proceeding spontaneously out of the body, or by some forces outside, would imply that human deeds were inevitable and uncontrollable. Hence, some power of choice in action is one of the axioms of a science of ethics, and a further implication should also be here stated. We do not say it is absolutely necessary to hold that human life is altogether good and desirable, but that we should certainly endeavour to make the best of it, and indeed that we can, whilst doing so, be of great assistance to others who are urgently in need of such aid. True, mundane life cannot be regarded as a great success. But little knowledge is requisite to convince one of the contrary view. The limitations to any very great advance are so obvious, that one cannot be highly confident as to man's earthly lot, at any rate in the near future; but still unquestionably there may be wonderful improvement, as there has been in the past. Yet, taking a broad view, we see so much cruelty and injustice, and so many wrong customs and laws, that we cannot be blind to them. Those who are gifted with high position and power have also obviously great duties, and should leave no stone unturned to render the lot of those who need help, happier and more healthy. This cannot always be effected by hard and fast rules, which may, unless very wisely framed and judiciously applied, work even more harm than good. Some difficulties seem to be well-nigh insuperable. All we can hope

to do is to lessen in some degree the sufferings of humanity. Many human beings find life difficult. It is not easy for anyone. Several people think, "It is hard for me, but so-and-so gets off very easily." This, however, is not the case. Each person's life has some difficulties, though others do not know them as a rule—unless they are either obvious, or explicitly stated. Even then, they are by many unknown, ignored, or lightly esteemed. Very seldom do they evoke either aid or even sympathy, save from the very kind. By most people, the victims of the most adverse circumstances, even when their troubles are acknowledged to be undeserved, are not helped, but despised and badly treated, and there is no cruelty so general as that of harassing one who is falling, or even supposed to be doing so, in order to speed the descent downhill, and so get rid of a distressing sight. However, it is a merciful fact that even such downfall and such treatment may be not unattended with compensations to the injured ones, for there can be no disadvantage which has no counterbalancing aspect. Indeed, it may be emphasized here that the idea of antagonism seems to be an indispensable method of thought, as indeed the origin of language exemplifies, the same word in primitive languages being frequently used to express exactly opposite significations. This was pointed out by Dr. Carl Abel, and it is seen even in the use of many modern words. The explanation is not by any means difficult. If it were always light, we should not know aught of darkness, nor could we conceive any correct idea of light itself. The same argument applies to our conclusions respecting morals. We could not know good, if we did not realize in some degree its opposite, bad, nor should we be capable of appreciating happiness, if we knew nothing of misery and pain. We do not say that our existence in that case would be vapid and meaningless. It would be a great exaggeration, and foolish, to do so ; but, at any rate, ennui is a well-recognized condition—and it certainly does not spring from pain, but from the absence of interest in anything.

Many of the occurrences of the Universe, especially storms, volcanic eruptions, earthquakes, plagues, famines, are, so far as the bodily life of living beings is concerned, very disastrous. The very conditions of physical existence are so exacting, that any marked interference with them renders its continuance either miserable, or more generally impossible. One can scarcely look upon the limited powers possessed by human beings as likely to evoke fully any very optimistic view of this life. Yet we can aspire to realize the lofty conception of some better sphere beyond all this striving.

Throughout the diverse operations of the Universe, a kind of compensation holds, so that what even may seem terrible catastrophes may bring some beneficial ultimate consequences. Not appreciating, or rather not believing, that this compensation exists betwixt the good and the bad, many people are led to believe that they can suggest far better, easier, more kind ways of action. One very essential point to be noted in this connection is that what is best for one may be damaging to others. Hence, we must not look upon life as isolated, and should

rather regard human beings in the aggregate, and try to do best for all. Unfortunately, the claims of the individual, and especially the comforts and luxuries longed for, often seem to conflict with the welfare of the community.

In short, if one wishes to aid the progress of the world, one must pay chief regard to the benefit of the whole human race, and not to that of classes, nor even of nations only. Nothing less than a consideration of this largest aggregate can lead to the formation of true conceptions of advancement. Even if the welfare of smaller portions be secured for a time, or apparently secured, the highest aim would still be the securing of the happiness of all. This word "all" raises a difficult question, viz., "Are we to include all races of mankind, savage as well as civilized, bad as well as good, whatever their customs and creed, habits, colour, and country?" This aim would involve paying due regard to Nature's inexorable ways, for she may be looked upon hypothetically as a factor steering in a clear way with a steady endeavour. Unfortunately, these ways cannot be looked upon as humane, nor even as just, so far as each individual being is concerned: for single lives, nay even the lives of nations, are sometimes sacrificed in the interests of the community in the one case, or of the race in the other. The chief merit of these modes is that they are apparently the most effectual which can be set to work. A consideration of them can also surely serve to raise a firm hope that there is some higher kind of existence to be obtained in the spiritual sphere, where one may not feel so troubled with personal cares and weaknesses, losses, difficulties, and inconsistent desires. "Are God and Nature then at strife?" it may be asked.

If we apply this line of thought to many of the current conceptions of our day, it will be at once obvious how crude and wrong are many of the rules which regulate modern life. No doubt reformers are inspired by the most humane feelings. Sometimes, too, their notions may be quite right; but, unfortunately, it is far more frequently the case that the methods they advocate, and too generally succeed in enforcing on others, are more difficult and costly, and at the same time less effectual in producing the desired result, than those pursued by Nature. The modern life we lead is, in spite of all its comforts and luxuries, and indeed to some extent by reason of some of them, not altogether free from mischievous factors brought about by interference with the eternal principles of true progress.

In no department of enquiry is this more clearly shown than in that dealing with the laws of health. The means by which animals and human beings alike can retain a healthy balance of vital processes constitute a very important study, and one needing all the best powers of the human mind to unravel. So far as each individual living being is concerned, the sum-total of the numerous external and internal conditions operative in this respect does not strike one as altogether satisfactory, for many of the provisions of Nature, if one may so speak, do not appear to be very successful, except when, as above implied,

we look upon their effects on aggregates of living beings. It is, indeed, only by so considering the matter, that we can thoroughly grasp, and acquiesce in submitting to, the laws of life. However, on closer investigation, the true state of the case may turn out sometimes to be both more humane and direct than at first sight it seems.

From the above considerations it is very obvious, as previously mentioned, that in all matters relating to conduct, knowledge is most essential. Many mistakes have been for ages, and still are, made, for no other reason than that they are not realized to be errors. There can be no doubt that most persons do generally act in what they suppose to be the way most likely to secure their own interests, and those of others dear to them, and the chief thing necessary is to teach the best ways, and how to avoid erroneous modes of action. Yet some can only learn by personal experience. The right rules of conduct are seldom completely known, and need the study of a lifetime. Not only are many complex factors involved ; but these vary repeatedly in many ways.

Few persons realize how very variable is the condition of a human being, how much it oscillates up and down without there being any actual disease. No doubt, the paralyzing effect of anxiety and seeming monotony has in many cases something to do with this, at least in the case of those who live the same kind of life, doing practically the same kind and amount of work without much variation, eating the same kind of food, from day to day. Variety is beneficial, and a change of diet now and again desirable, nay, sometimes essential, for health. Advantage can be gained from a judicious temporary change of abode and occupation, from temporary rest perhaps, or alteration of character of activity. If to these be added the well-ordered *régime* of a scientific hydropathic or electro-therapeutic establishment, the bracing air of the sea, or perhaps a residence among pine trees at a high level on a gravelly or sandy soil, coupled with some skilful massage or outdoor exercise, and perhaps the employment of mineral waters, much good may be done.

The life of a human being is often quite needlessly snapped asunder, as for example by so unwise a procedure as running excitedly to catch a train, whilst one is either temporarily or permanently suffering from some disorder of the heart or the circulatory system. It is important to make the best of life ; but to do so, as above said, involves a very high kind of knowledge and power. One may not be cognisant of several of the resources and appliances for correcting derangements of the system, for maintaining or restoring good health, and thus aiding the carrying out of the work which still needs to be done for the welfare of all. It is, indeed, the task of a lifetime to gain such information as gives the power to decide what is best in each case.

Some people, not apparently ill, live, so to speak, at a very low ebb, giving way to gloomy thoughts, and even gradually to despair, and get so enfeebled, as scarcely to be able to exert themselves to take necessary exercise. Then, perhaps, some serious disease may implant itself in

such debilitated constitutions, the next step being confinement to bed, and then, perhaps, a more serious turn leads to death. In large cities especially, one can hardly escape altogether, occasional contiguity with the germs of disease, and almost every public building contains them in greater or less degree. No doubt, when one is run down from any cause—over-pressure of work, anxiety, or the like—the receptivity towards disease is considerably augmented.

It is, of course, obvious that houses and buildings should be thoroughly ventilated, and cleaned constantly, in order to lessen such dangerous conditions. Special measures of ventilation are requisite in places where large numbers of people congregate together. There is also, as implied above, great benefit to be derived by now and again removing oneself from the noxious germs, and the turmoil connected inseparably with densely-populated places, because persons, who are highly sensitive to the influence of depressing factors, are liable to become very ill, without being actually attacked at first by any definite disease. The more completely one observes the conditions of health, the stronger one becomes, the more efficient one's results will be, and the longer one may expect to live. Even a slight change of surroundings and habits may bring a change for good in the bodily and mental state, which may also come as a revelation to one who has forgotten what degree of health and happiness could under good conditions be enjoyed, and with what ease they can then accomplish tasks, which otherwise could not be even entertained without shrinking.

Turning now to a deeper review of the idea we started with, from which we may seem to have somewhat diverged, we ask, What kind and degree of compulsion is found when one searches right down into the very heart of the Universe ? The answer seems to be—such compulsion as is at once necessary, and at the same time as far as possible consistent with a large degree of freedom. On the one hand this compulsion is unerring ; but at the same time some might regard it—though not justifiably—as even haphazard, so extraordinarily unbounded is the liberty associated with it. Indeed, there is only one check to it—and that is the impossible. Short of impossibility there is no compulsion in Nature ; but it is a decided fact that that limit cannot be overstepped by any means whatever. The sea goes just as far as it can, not one inch further, the wind blows apparently where it listeth, but really where it must, and whilst the planets move and revolve in just such a manner and to such extent as the various attractive forces allow—nay, compel—the course of their changing in every other respect is, though doubtless likewise inevitable, still remarkably variegated. There is very little sameness or monotony in Nature, nor are there many hard and fast rules, and only, as above said, such compulsion as restraint from the impossible involves ; the possible for each aggregate, regarded as a unit, being apparently determined by the necessity of not interfering with the maintenance of the freedom of other similar aggregates—at the peril of extinction of individuality. All the processes of the Universe may be mentally represented as either the joining of separate entities,

or the separation of them, or as a combination of both processes in co-operation, and, indeed, the highest aggregates are those which combine the greatest internal freedom of movement of parts, together with the most marked cohesion of them, or linking of their actions to a common end.

Similarly, in regard to the phenomena of life, the same rule holds, and there can be no steady advancement without freedom. However great and brilliant a nation may be, if its rulers lose touch with this spirit of freedom, of elasticity of regulations, the seeds of decline and fall are inevitably sown, and will certainly grow, and bring more or less ruin sooner or later. The errors of legislators have been so great; that it is almost a wonder that they have not done even more harm still. Modern nations, in spite of their complacent satisfaction concerning their political wisdom, are conspicuous examples of cramping laws and customs. Undoubtedly, however, the knowledge we possess is likely to go on advancing at a rapid rate. More especially in regard to power over the operations of Nature, we are obviously far ahead of our forefathers. No doubt also this greater competency to deal with occurrences in the world has increased the breadth of mental insight; yet, strange to say, the writers of this day are not so conspicuously superior to their predecessors, as might have been anticipated from the wider range of observed facts at their disposal, and there is an enormous amount of careful and thoughtful work to be done, not only in the sphere of research, but also in that of the co-ordination and interpretation of recorded observations, especially in regard to what are known as the abnormal processes of organisms.

Doubtless, the collection of facts is a most important work, but it is also most necessary that they should be truthfully interpreted, and properly placed in their right position. Otherwise, not being thoroughly explained, they are not generally understood, and are therefore taken no account of, or even lost sight of altogether. The idea of evolution can certainly be applied to the diseases and derangements of living organisms, and, especially in recent years, glimpses have been gained into the causation of many diseases. For example, brilliant researches have recently disclosed the fact that malarial fevers are propagated by certain kinds of mosquitoes (*anopheles*), which, being themselves infested with certain microscopic animal parasites, communicate them to human beings, by biting. The discovery of some of the numerous factors involved in diseases, including those of minute pathogenic animal and vegetal organisms, has greatly simplified the explanation of the abnormal phenomena exhibited by higher animals.

Whether one feels that the key afforded by the idea of evolution is altogether satisfactory or not, is not a question which we propose to discuss in this connection. It is taken for granted as an axiom—nay, rather as a postulate—for the sake of a brief consideration of some aspects of natural processes which we know do occur. Moreover, it is suggested that we should throw the idea back to a far-off past, and not merely take that section of it generally known as Darwinism. Rather,

one would apply it, not only to living beings, but also to inorganic aggregates—in short, to all the contents of the whole Universe. Nevertheless, in passing, one may here mention a striking illustration of the probability of kinship betwixt apes and human beings, recently observed by a doctor, who has found that the serum of a rabbit treated with human blood produces a sediment, and also with ape's blood, but with no other kind of blood.

Now this is a point of considerable interest, and, even if we do not accept it as strong proof that human beings and apes have descended from the same primeval creatures, we must at least admit that it furnishes presumptive evidence that this is the case. Moreover, we may suppose, for the sake of argument, that all living animals came from a common origin—probably a marine one.

If we assume that all living things are descended from forms of life which were marine, and almost structureless, they would have been saturated with sea-water ; for not only would their external surfaces have been almost constantly exposed to that liquid, but also it would be, in most cases and times, the only fluid they could take into their interior. Hence, it would seem that the salines of that liquid, and its other constituents, would be all used, and become serviceable for vital processes. These supposed primeval organisms may have given rise slowly to fish, whose skeletons were cartilaginous, or even less highly organized still; to amphibians, which breathe by lungs as well as gills; to reptiles, birds, beasts, quadrupedal mammals, and quadrumana, culminating in human beings.

If, then, the organisms from which all existing animals have developed were marine, and life sprung up at first in the sea, it follows that the food of these original creatures must have consisted of other marine forms, both animal and vegetal, whilst terrestrial beings would feed on land- and water-organisms of all kinds. Marine forms would be mainly carnivorous, terrestrial ones at first would probably have been mainly herbivorous, living on roots for the most part. Man is now omnivorous, and probably has been so from the first. The change from the sea to the land would be necessarily accompanied by a gradual change of drink from salt, to more and more fresh, water. We may assume, at any rate, that human beings are the descendants of lower forms, whose lives were subject very likely to marine conditions, and it is possible that the need for similar conditions may at times re-arise amongst ourselves.

It is possible that the beneficial effects of sea air, of bathing in the sea, of fish diet, of the medicinal use of preparations of iodine, of bromine, and of sulphate of magnesium, and in like manner the craving for and need of chloride of sodium, apparently existing in all animals, may be readily intelligible on the hypothesis of a marine origin of life.

Again, iron is a widely-distributed element—especially on the land,—and, indeed, it would be impossible for terrestrial organisms to subsist on any food without ingesting an appreciable amount of that metal. Hence, it is explicable that both in animals and in plants it plays a most important part.

Of both chlorophyll and hæmoglobin, iron is an indispensable constituent, and this fact is no doubt the best possible arrangement, resulting as it does from the various factors and needs concerned. That chlorophyll splits up carbonic acid gas in the presence of sunlight, is perhaps connected with the corresponding need for oxygen in animals, and, further than this, it is at least likely that the composition of these two substances, chlorophyll and hæmoglobin, is also causally connected, both by the fact of animals living on plants, and also by the supposed fact of the origin of both animals and plants from an intermediate kingdom.

Yet, perhaps, for that very same reason, i.e., its almost universal presence, iron is not by any means the most potent germicidal agent, though it has some of that capacity. Hence, now and again in certain conditions that metal needs to be supplemented.

Moderation.

Much that is injudicious may be discerned in the general tendencies of civilization, and now and again one may note a retardation of so-called progress, when it is very unwise. Currents of popular opinion may be at times almost irresistible, and yet they may be incautious, rash, and wrong. Before it is decided what measures should be taken in order to secure some good end, we should remember that Nature has unerring modes of her own of bringing about results, and be careful lest our puny efforts militate against her safer and surer methods. The best States may be those which are not rigidly governed by too many hard and fast rules. The unseen conditions regulating human progress can easily be upset by hastily-made enactments, which, so far from aiding, may retard the advance of the world.

On first noticing something very wrong, one is very apt to think : " Now here is an abuse, or an injudicious custom. This folly must be corrected, and with this purpose, a certain law or prohibition must be made." However, many aspects of the point should be considered, and some of these may seem to be antagonistic to others.

It is quite true, for example, of tight-lacing, cramming, or even merely excessive though legitimate education, or, on the contrary, too little learning, or, again, of excessive cycling, rowing, or dancing, gambling or betting, the addiction to alcohol, tobacco, morphine, chloral, Indian hemp, or absinthe, that these are wrong. The question is, what steps can be taken which are likely to lessen the admitted evils ? In some cases it is the abuse, and in others even the neglect and not the use, of the substance, that is wrong. It would be obviously absurd to say that because A uses morphine badly, B must not have it to relieve the pain of a cancer, and yet a similar course is the one that some reformers would almost seem to advise in regard to alcohol. There is no question as to the intense amount of harm done by these various evils ; but a too stern repression may not so well succeed as a careful teaching of the grave dangers resulting from the various injudicious actions. Yet, as before said, ethical precepts are not, and cannot be, rigidly fixed,

for they must in some degree vary with varying circumstances. Sometimes it may be that one has to choose—not betwixt a right and a wrong action—but between two or more courses, of which not one can be deemed either clearly right or clearly wrong.

Life, looked at broadly, is at any one moment an aggregate of compromises, whilst, looked on as continuing, it is a series of aggregates of compromises. Morality, similarly, is a compromise betwixt various needs and desires of the individual on the one hand, and of duties arising from the claims of others, these claims resting in their turn on needs and desires of these others.

In attempting to help, one may be a great source of trouble to those we desire and try to assist, and human beings, like animals, may bring injury, and sometimes even destruction, on those they love by actions prompted by love, not only when physically, but even when emotionally or mentally, expressed, e.g., by advising wrong or unsafe courses.

Some of the zest and flavour would be taken out of life, if it were unnecessary to expend energy in order to do good work. The conditions of the world are not stationary, and what was well suited to our ancestors will not do for us. We must keep on advancing, and cannot rest satisfied with rules laid down in very different stages of progress. No event is quite isolated, but bears a relation to innumerable other events going on simultaneously, besides those that have preceded, and will succeed it. Hence, every occurrence is complicated by various coincident, precedent, and sequent phenomena, more or less inseparably connected as the case may be. Our ideas of what is bad and good must to some extent therefore be modified by a consideration of these side-issues and factors. An action may thus be seen to be apparently good and desirable in itself, and yet be bad—on account of inevitable, probable, and possible consequences, both coincident and sequent. On the contrary, a deed or an occurrence may appear to be bad in its own nature, and yet be both attended with, and followed by, advantageous results. A sea-voyage may prostrate with sea-sickness for a time, but the invalid will probably recover, and feel a new person, launched successfully on a new life. The withdrawal of a decayed tooth may be a great shock ; but will probably lead to a far better state of health. On the other hand, undue indulgence in tobacco or wine may be very pleasurable at the time ; but will probably exact a heavy penalty afterwards. Medical men, who see behind the scenes, could many a tale unfold of lives shattered by alcohol, of deaths most terrible. Smoking, too, is doubtless very deleterious, especially to those who are highly sensitive. Probably, the more highly advanced a human being may be, the more injury is sustained from such bad habits as smoking and drinking. It may be urged that these and similar evils are purposely selected by many people, in order to draw away the attention from other worse temptations and cravings, which are more dangerous and more undesirable still. Smoking is no doubt largely a question of imitation, one boy often leading another into a practice which seems to them both a manly habit. It is also chosen on account of the

fragrant and powerful smell, the slight disinfectant action, the desire, and, perhaps, in some cases, the need for a vegetable alkaloid, which may have been formed in ancestral times when human beings lived mainly on roots. It is indulged in, because it seems to lull doubts and deeper questionings, undue consciousness of self-existence, anxiety, worry, grief, morbid fears, restless mental disquietude, desire for activity and indulgence, as well as the realization of both the presence and possibility of insurmountable difficulties and dangers existing not only in the environment, but even in one's own nature. On the other hand, it causes inhibition of the vagus nerve, which controls the contractions and actions of the heart, and so brings about a rapidity and want of regularity of those actions. Also tobacco tends to stimulate the peristaltic action of the bowels—one of its greatest benefits. Thus, whilst it acts as a sedative in part, it also acts as a temporary stimulant. It is said that some writers, of whom I believe Mark Twain is one, state that its influence is to stimulate thought ; but, whilst this may be true of some few, it is probably more destructive of clear thought for most people. On the whole it brings for most people more harmful than advantageous results, and, unless one be well endowed with good circulatory power, should not be indulged in. If the heart be weak, it certainly is very injurious, and also, as a rule, if one be in any other way out of order or ill. Still, for some it may act well for certain purposes, as above said, and it has some disinfecting power. For the majority, however, it is unnecessary and undesirable. Inhaling freely smoke from cigarettes is very harmful. If one does smoke, it is best to take the smoke into the mouth only, and quickly expel it, not inhaling it, nor passing it through the nostrils. A good and fragrant cigar smoked thus may not do great harm. In regard to all such matters as smoking, food, drinking alcoholic liquids, and the passions, self-restraint is advisable, and the less one indulges in any excess, the better one will be. Some, of whom Mr. Carnegie is one, hold that total abstinence from alcohol and tobacco is best, and in the general way this contention is probably true. If plenty of exercise and fresh air are taken, it will not be found difficult to desist from these indulgences. The exercise should be well regulated and not excessive, and the craving for tobacco and stimulants will be found less strong, the longer one does without them. It has been said that soldiers on the march are better able to bear prolonged fatigue, if a little tobacco be allowed ; but perhaps this may be the consequence of an acquired habit. In any case, one need not be unduly rigorous in such cases, because smoking is not always easily relinquished all at once, and also in certain cases it may stave off infection, or even produce some required action.

In regard to the habits of daily life, knowledge can only be taught gradually, and, indeed, there are some questions which cannot yet be definitely settled. It is, however, universally agreed that moderation is most necessary, and especially in regard to alcohol, tobacco, food, exercise, work, pleasure, and the passions. Indeed, self-restraint in such matters is one of the primary essentials of health. Control should

be shown in both eating and drinking, but a due amount of good food, pure water, and air, as well as of work, rest, recreation, and sleep are essential. Enlivening amusements and health-giving exercises are beneficial. Music and singing afford cheering relaxation during the intervals of rest from work, and divert the current of thought into new and joyous channels. It is not possible for all to devote their life to literature, but pleasing and ennobling books are exceedingly valuable. They should be at hand, and, indeed, more widely and numerously disseminated than is as yet the case. Even a single page of a good work—nay ! even a sentence—might perchance influence favourably a whole life.

Excess of any kind should be avoided ; but, unfortunately, many people seem to be very prone to carry habits and actions to extremes. One may even read or write too much. It is not only in play, but also in work, that moderation should be exercised. Some eat and others drink too much, whilst still others do too little of either one or the other. The fasting, lately come into vogue, may become very dangerous, and, perhaps, even be fatal. Then, also, in regard to diet, it is quite possible to become too exclusive, and some strict vegetarians, with their absolute prohibition of salt, tea, and alcohol, may become unreasonably restrictive. Salt preserves food, and also supplies the hydrochloric acid of the gastric juice. Some people unquestionably eat far too much flesh-food ; but, no doubt, man from primitive times has been mainly omnivorous, and, at any rate, what suits one may not suit all. In any case, one cannot be advised suddenly to restrict oneself to fruitarian and vegetarian diet, although one may, of course, be gradually accustomed to it. At first, it is difficult for the body to adapt itself to a complete change. There may be, too, much difference of opinion as to tea, coffee, and tobacco, though alcoholic drinks taken immoderately are well known to produce most injurious results. Every breach of wisdom brings its Nemesis, and one should be very careful not to acquire bad habits, but make the best of ourselves in every way. Intemperance of every kind is very inimical to our mental and bodily well-being ; and we should always have regard to moderation in all things.

The people of Great Britain are becoming more temperate, and one of the reasons is because it is recognized that drinking is incompatible with success in athletics. Some publicans supply tea, coffee, and soups, and thereby encourage abstinence from alcoholic beverages. In the last six years there has been a decrease in the drink bill of Great Britain of £21,750,286, despite the increase of population, and this represents an expenditure of £3 15s. 11½d. for each individual.

Beer has on an average only 5 per cent of alcohol, whilst spirits have ten times as much. Still thirty-one gallons of beer per head constitute a serious amount, especially when it is added that spirits may be taken as well, and also that numbers of people take none.

It is said that twelve towns are responsible for 23 per cent of the total national outlay.

The average annual consumption for each European male of proof spirit amounts to four gallons.

The effect of alcohol is to cause temporary paralysis of the nervous system, and extra beats of the heart, i.e., 8000 extra daily, if only a fluid ounce is taken. If a large quantity be taken, it may easily cause five times as many as the normal, increasing the number from 5000 to 25,000 beats in the day. In large doses, indeed, the nerve-centres are put in abeyance. The skin acts more powerfully, becomes fuller of blood, owing to dilatation of the cutaneous blood-vessels, whereby flushing with greater heat and moisture are produced therein. The feeling of warmth is caused by the rush of blood to the skin, and this really produces a cooling of the body. Neither heat nor strength result, but really a checking of vital processes, especially digestion and oxidation, upon which life really depends.

Thought is stimulated for a time, owing to increased vigour of cerebral circulation ; but such stimulus cannot be obtained without subsequent flagging of the mental powers, and there is danger from the unnatural blood-pressure, especially for the weak and diseased. If taken at all, it is best to drink it at a rather late meal, e.g., dinner at 7 p.m.

The body, no doubt, needs flushing with fluids ; but hot water of good quality between meals is best for this purpose.

The Yogis of India believe, as do modern scientific men, in the necessity of keeping the interior of the body thoroughly clean. It has been said they absorb large quantities of water per rectum whilst bathing.

It is obvious that a more strict moderation in regard to alcoholic drinks, tobacco, eating, and every form of activity, whether by way of pleasure or work, is desirable. Stimulants give merely temporary relief from anxiety and depression, and when this effect is over, misery is apt to arise. Undoubtedly, much suffering results from inordinate use of stimulants, and it is necessary that the public should know the grave and insidious dangers of indulgence in them. If taken in excess, alcoholic drinks work great harm, shattering constitutions and causing horrible deaths. Hence, realizing this great truth, some would advise methods of compulsion, which they suppose would be capable of making people sober by Act of Parliament. Such regulations, however, although at times apparently indispensable, should be viewed with suspicion, and as only to be enjoined, if at all, in cases of real necessity for the sake of the public welfare. Compulsion may be either wrong, or only wise for a brief period in any given case. So averse, indeed, is the public as a rule to any compulsion, that such action may easily be nugatory, on account of the opposition it excites—and this, too, even when it is well known that the regulations are made for a good purpose. Any interference with freedom, especially in regard to so-called pleasures, may thus not only lessen, but even be apt to intensify, the errors and mischief aimed at. Hence, legislators should act with very great caution, lest they should augment, instead of diminish, the

evils complained of, and lest they should oppress the innocent, instead of punish the guilty. Before enjoining compulsory enactments, therefore, every possible result of such measures should be fully considered. In regard to the evils of drink, legislative action seems inadequate, and well-nigh impotent. Doubtless, much progress in temperance has been made ; but it is probably due rather indirectly than directly to laws. That is, it is evoked by education. There is risk that, in attempting to do good, not merely futile but harmful measures may be passed. Wisdom cannot be taught by Acts of Parliament, and legal modes of prohibition cannot render those temperate, who are not naturally or by reasoning inclined to be so. Voluntary self-control is what should be desired. Such questions as this one of temperance are vital to the welfare of the human race. However, whilst striving to do good, one must avoid doing harm, and regard with distrust all hasty and ill-considered views, for it is far better to abstain from action than to act wrongly and injudiciously. Even the best intentions may not secure any good, but may bring harm. In order to be sure, progress must be careful, and is usually slow—not forced, but voluntary. Compulsory virtues may be said to possess a negative value, in so far as that, if and when the brake be removed from the wheels of conduct, or when it is learnt how to avoid and evade the legal impediments, the restrained forces and impulses burst forth, like the torrent of a river, when the dam is withdrawn. The ways of nature are deep and subtle, and no seeming failures should depress us.

> " Sweet are the uses of adversity,
> Which, like the toad, ugly and venomous,
> Wears yet a precious jewel in his head."

The stimulus of necessity is useful to many, and it is really often more arduous for some people to do well when prosperous, than when dark clouds of adversity obstruct the bright rays of the sun of success. Oftentimes lack of success is a highly potent spur prompting to profitable activity, and it may also be of advantage in making one compulsorily abstinent from harmful luxuries.

However, one should not become so fanatical as to abstain, or counsel abstention, from a little brandy or other spirit and warm water, if occasion should require it ; and, although it is said that alcohol lowers the body-temperature, it may still serve to protect against taking cold, if one be exposed to severe weather. It is useful for pains in the body, especially griping ones, and faints, but dangerous in apoplectic fits. Alcohol and tobacco should be used as medicines—and only in great moderation. Sometimes a pipe after a hard day may be useful, by preventing or lessening worry, and inducing sleep. It is not judicious to smoke either soon before or after a hearty meal, since all the heart's best powers are then needed, and tobacco depresses the regular action of that organ. It is best to wait until after the post-prandial coffee, and then perhaps indulge in not more than one good cigar and a gentle walk. Severe exercise arrests digestion.

A fair amount of refreshing exercise is beneficial, and it tends to the

clearness of mind and lucidity of thought requisite for good work. Excess of exercise, as of work, is harmful ; and whilst a little relaxation and change in work and of locality are desirable, pleasure in excess may be very disadvantageous. After a hearty meal, such as dinner, time for digestion should be allowed prior to undertaking any hard task or exercise.

Intemperance may be displayed in regard to the passions, and it may be said that envy, hatred, jealousy, and uncharitableness are most injurious to health. Indeed, it is obvious that self-control in thought, speech, and action should be exercised in order to prevent all extreme manifestations. Some people are by nature passionate, even to the extent of having hysterical fits occasionally. Thus is seen the harm of undue excitement or strain, which may upset the mental faculties for a time, or even permanently. In such a fit there is experienced at first a sense of choking, and then wild convulsive movements, together with, or followed by, partial or perhaps almost total loss of consciousness. The pupil generally reacts to light. Finally, laughing, or crying, or both, occur, and there may be a discharge of urine. It differs from an epileptic fit, in that the insensibility is not complete, and the respiration is not obstructed. The pain, too, is unlike that of real neuralgia, because it does not coincide with the distribution of any nerve.

Chapter VII.

SLEEP, SLEEPLESSNESS, SHELTER, AND HABITATIONS.

Sleep.

It is not easy to lay down any definite and unvarying rules as to the number of hours really requisite. The amount requisite is variable —by no means always the same. Two points, however, may be at once mentioned. Firstly,—with the exception of certain cases, such as sleeping-sickness and the very prolonged stupor, whether induced by drugs, or by certain derangements other than that named,— the desire for long sleep is generally an indication of its need. It is in all cases indeed to be looked upon as "nature's sweet restorer." The other point is, that some people, whether by habit or constitution, really require more hours than others. One must, therefore, be guided by all the circumstances of any given case or cases. The Austral-Negroes, Papuans, and Andamans are long sleepers, as indeed, according to Tacitus, were our own ancestors. For most persons on an average about eight hours' sleep may be requisite; but many take more with advantage, and in some cases no doubt to do so is judicious, and often gives the necessary time required for warding off a severe illness. Some people take far more out of themselves than others whilst awake; and also sleep varies much in depth. Moreover, in the case of those who use the brain much, sometimes a long time is required in the recumbent posture before sleep occurs. Hence, the number of hours in bed does not nearly represent the amount of sleep obtained, which is of course far less. Profound dreamless sleep is very refreshing, and if the air be pure, a little of such a kind will suffice better than a great deal of restless and incomplete slumber full of confused and, perhaps, terrifying dreams. If it be windy, it may be best to close the window, or insert wedges, as rattling window-panes are disturbing influences. Cotton-wool ear-plugs waxed may be tried, instead of closing windows (Saleeby). One, however, can become so used to noises, as not to be prevented by them from sleeping. The rest is, however, probably never so complete. Some people for various reasons, as said above, really seem to need more sleep than others do, and probably brain-workers need more than those leading an active life. It is all very well to think that people are idle and indolent, because they take more hours' rest than others think necessary. One must remember that some, who pride themselves on their abstention from long repose in bed, often supplement those hours by a nap after dinner, or at other time in the day. There is also another point, and that is that they often die at an earlier age than those who take more rest, as well as suffering from loss of energy and strength prematurely. To a large extent this matter of

the amount that is required is a question of health and vigour. If one is constantly exposed to baneful conditions, more time is required for the protective and restorative processes which go on most actively during quiescence. The quality of air breathed both during the day and at night-time has also much to do with this question. Many people do not appreciate the immense difference purity of air makes. Most of us who live and work in large towns do not really lead a healthy life, and hence more rest is required to protect and recuperate the system, and aid it to fight its constant battle against disorder and disease. The wear and tear and worry of our daily life must require time to be antagonized, and those who do not allow, or are not allowed, this necessary time, may have to pay dearly for the want of it by a long illness—sometimes ending in permanent incapacity, or death, or at best in a state of diminished power. One living in the country in a healthy part, resting with the window generally open, does not want much sleep as a rule ; but will probably wake up so refreshed, as not to have the least desire to remain in bed. Such an one cannot perhaps understand how another can possibly want to lie for a longer time in a recumbent position, which seems a mere unnecessary indulgence. Forgetting that one man's meat may be another's poison, the rhyme occurs to the mind :—

" 'Tis the voice of the sluggard.
I heard him complain ;
' You've waked me too soon :
Let me slumber again ! ' "

The fact is that if one wants more rest than the ordinary amount required, it is a sign that there is something wrong, which needs rest in order to be set right. The initial signs of an illness may be sleepiness (especially of some forms of influenza). A change to a healthier residence may bring about a complete change in the amount that is taken. As above said, if the air in the retiring apartment be good, and the window kept open, less time will be needed. Instead of a headache in the morning, the sensation of a fresh and clear brain is joyfully experienced. If one has been used to reposing with the bedroom window closed, and then adopts the custom of opening it, the greater vigour caused by the purer air breathed will impart freshness and liveliness in the morning. This will be all the more apparent if one be residing near the seaside, or in proximity to pine woods, or at a high elevation. In order to show that it is not merely a proof of indolence that one desires a longer time in bed, one can try lying in bed for a day or two, in which case, even if meals be regularly supplied and attendance adequate, it is soon found to be an intolerable infliction. The same is seen often in children, who regard it as a severe punishment to be sent to bed in the daytime. However, if one has been much overworked, and is greatly run-down in vigour as a consequence, one not only needs, but also desires, a good long rest, and many minor ailments which compel rest in bed for a few days undoubtedly actually prolong life, by giving the system time for making up lost ground. Animals,

e.g., cats, often take prolonged spells of rest, and are at such times very unwilling to be disturbed. Moreover, they actually sleep, curled up in a ball-like form, as will be again referred to, with the view of preserving the heat of the body, and lessening the chances of receiving injuries. We have personally known a cat to sleep with scarcely any motion at all, being almost absolutely quiescent in a curled-up state, for something like ten hours, and when disturbed, only getting up with evident signs of wanting to repose for a longer time still, and this a healthy and normal cat. Moreover, if one is ill, the desire and need for prolonged sleep is often irresistible, and there are kinds of influenza which seem to produce such need. We have known people suffering from that disease sleep almost uninterruptedly for two days or more. If suffering acute pain, they do not sleep much; though ordinary pain will not keep people awake for very long. As is well known, the greatest mental torture results from being compelled to keep awake, and the Chinese are said to punish people in this manner.

> "Early to bed, and early to rise,
> Make a man healthy and wealthy and wise."

The first part of this proverb is probably generally preferable to the latter part of it. Early rising is all very well for hardy persons who are accustomed to it. Weak persons, and particularly bad sleepers, are apt to become soon exhausted, if they rise before 8.30 a.m., and are thereby unfitted for the day's work. The habit which some persons indulge in in regard to early rising, taking cold baths, and walking out, and especially bathing out of doors before breakfast, may be for some very deleterious. Warm or tepid water is more suitable for such as are weak, and those advanced in years.

More sleep is requisite for infants than for those who have reached middle age. During old age or during convalescence from acute maladies, persons should spend much time in rest. Nervous, excitable people, and all who are not strong from any cause, need more sleep than robuster persons, simply because the events of each day in their case involve more wear and tear. In any case every one should have eight hours' sleep, or even nine, and this means some ten hours at least in bed. Still, though this amount may be enough for the average healthy person, it does not suffice for all and under all conditions. Some really need more than others, though the reason is not always manifest or easily traceable. Those who take plenty will often be seen to remain healthy and strong, and live longer than others who habitually take too little. There are, indeed, a fair number of people who take and seem to require nine or ten hours' quiescence daily. Much depends on the nature of the sleep, and the kind of air breathed. If the air be very good, as said above, less sleep will suffice. Usually the bedroom windows should be open. Perhaps a good rule would be to rest, when it is possible to do so, as long as one wishes and feels the need. Those who remain long quiet, say they feel better for the extra hours spent in repose, and do better work more easily after it.

It is often said that the hours before twelve, midnight, are better for rest than those afterwards. No doubt the old-established routine and the absence of sunlight has much to do with this. Animals, so far as possible, obey this rule, except in certain cases for obvious reasons, e.g., rabbits, rats, and mice have usually less to fear and more to gain by lying low during the daytime. One reason why it is wise for human beings to retire early is that the sitting-rooms generally get almost devoid of fresh air by night, owing to the combustion of gas and coal as well as the respiratory and other functions of the in-dwellers, and hence one is breathing as a rule a very poor or bad air during the later hours. Another point is, that people should be gradually and not abruptly aroused from deep slumber, and it is best to collect one's faculties before getting out of bed. Sleeplessness may result from bodily pain, or mental anxiety, or disquietude, and other not well-understood conditions of disturbance of the system, such as may perhaps result from certain electrical changes in the atmosphere, and even, it is said, in some highly-strung people, by varying phases of the moon. As a rule narcotics should be avoided, as they do so much harm ; but when really requisite, they may of course be carefully used to allay pain, and so produce sleep when the lack of it is in that way caused, and in some other exceptional cases they may be with caution employed. Sleep may sometimes be procured by assuming an easy posture in bed, and concentrating the mind on a subject remote from the ordinary thoughts and daily work, or on one as free as possible from disagreeable emotions, or by turning the eyes so that they look upwards, as if to a known constellation such as Charles' Wain, or to a lark supposed to be warbling in the sky, and thinking of oneself as if seated on the wagon driving the team of horses, or as encouraging the lark to sing. This may be coupled with the thought that, though one is but a small part of the sum of things, still one must act in accordance with the aspiration to do the best. A little deep reflection such as, for instance, a recognition that, when thinking of himself, a man is at once the subject and the object of the consideration, the seeker and the sought, may be sufficiently perplexing to be helpful in causing sleep—especially if, turning to other organisms, it is realized that the problem of life in them is also complicated by the fact that the man reflecting on it is himself a living being. Obviously man, in common with other organisms, is transitional, and his reasoning processes have but a relative value. The conditions necessary for mental activity, since they imply a high degree of instability, whereby external forces may produce internal reactions, must also conduce to a great amount of restlessness and changeability. All living beings are unstable and liable to change, decay, and destruction, and the more complex an individual becomes, the greater becomes the liability to these. Still, we must try to progress, and not be discouraged by the realization that we can only arrive at relative truth.

The best cure for sleeplessness is duly regulated exercise of body and mind. The head should be raised with pillows. Excessive anxiety to

sleep prevents it, whereas the desire to keep wakeful may induce it. A little food, but not a full meal, should be taken, and then a little interval allowed before retiring. If sleepless, try to lie quiet. In some cases reading a light or humorous book may be useful.

In slumber one is not sensitive to ordinary external stimuli; but the degree of such insensibility varies greatly, and is due to a quiescent condition of the brain-cells, and also to a diminution of activity of the circulation. Sleeplessness may be caused by worry, or by the anticipation of some event, whether pleasurable or painful. Pain acts so as to cause inability to sleep in two ways, viz., by increasing the activity of the cerebral cells and that of the circulation. Other causes of wakefulness are heat or cold, hunger or thirst, distention of the stomach or intestines, an acid or other irritating state of the stomach, or irritation of any part of the intestinal canal, indigestion being a fruitful source of uneasiness.

Sleep and Shelter

are allied, because man, like all animals, passes the night in sleep, and also for this purpose, like them, too, seeks to hide and protect himself during the hours of repose. Birds get into their nests, wild animals into the bush, and monkeys make a couch in the tree. Primitive men prepare a shelter for the night. In the daytime the Negro leaves the mud hut, and the Indian the leather tent. The shelter is also, of course, for protection against rain, cold, heat, and wind—both for the human beings themselves, and also for their fire. Animals not only seek shelter for sleep, but also from stormy and inclement weather. Mankind is, of course, still more desirous of and dependent upon being guarded from excess of heat, or cold, light, wind, rain, snow, hail, sleet, or lightning. Still, like other living beings, man really needs much out-door air and light, though many get habituated to too little of these necessaries.

It is interesting to note that animals usually sleep curled up, so as to expose as little surface as possible to radiation, and therefore to loss of heat, accidental injury, or attack, naturally curved into a ball with the most vulnerable parts internally situated. Similarly, primitive man, e.g., the Bushman, sleeps with the body rolled up. The cousins Sarasin say that the aboriginal Weddas sleep with the senior in the centre, his bow and axe near by him. Around and near are the children and younger members of the family, closely huddled up so as to retain warmth, whilst others of the group place themselves a little further off. The Austral-Negroes lie down in couples or threes, with arms and legs entwined, and the Negro sleeps in similar groups. Tribes which have no permanent dwellings creep near the ashes of the fire for warmth, and this is the origin of the bench on or over the stove, which is seen in German and Slav peasant houses. The exigencies of moral considerations are in nearly all peoples regarded. Even the low Bubis of Fernando Po, according to Oscar Bauman, provide special sleeping huts for boys and girls, and only one child is allotted to each room.

The Nutka Indians of the North American North-West, the Dyaks of Borneo, and some South American tribes, erect large houses, four storeys high, as the habitation of a large group of people. These large club or society-houses are for a single tribe. One storey or division is for widows and unmarried women, one for widowers and bachelors, one for married couples, and one for children. The Mortlock Islanders and Bechuanas have a separate house for the women ; and the Malays, Polynesians, and Papuans have houses for bachelors.

Migrating peoples make their bed wherever they may be when the shades of night fall. The " weather-board " is made of branches and twigs laced together, and this is placed in such a slanting position as to protect the man and fire against the wind. A next step is to place branches and trunks of trees in the ground, arranged in a circular form, and then to make the tops meet together above, bind them, and cover with more branches or skins. This sort of rough tent is made by all nomadic tribes. The next stage is that of the conical dwellings, shaped like beehives, of the agricultural negroes. Then come the wood and bamboo houses, provided with square floors, of the Malays and Polynesians and other tribes of the South Seas. These are the best timber-constructions of low peoples, except the wooden palaces of Central Africa and the Congo. The Esquimaux erect huts of stone or snow.

Huts of pounded or stamped clay, with straw roofs, in Central Africa may be compared with the clay-brick buildings of New Mexico and Central America. The stone-dwellings of the Central Americans, Polynesians, or the Incas, are represented by more skilfully constructed ones among the historical nations of Asia and Europe, and still more so in Egypt and Mesopotamia, where the true art of stone-setting was practised. Pile-dwellings on lake and on land are of frequent occurrence among the Malays and Papuans, and in China and Hindostan. Dwellings in trees are rare. (Notes taken from Dr. Haberlandt.)

The site chosen for habitations should be healthy, the soil not malarial. Houses should be cleanly, well arranged, and comfortable—well and efficiently provided with every need, such as baths, water-supply, drains, and water-closets. All angles and corners of the buildings should be rounded, concave moulding being placed where walls and floor meet. Beneath the building there should be service subways for the conduction of pipes for heating, water-supply, and removal of excreta.

The air that is given off from the lungs of human beings contains water, carbonic acid gas, and other impurities. In order to obviate the disadvantages thereby caused, ventilation is requisite ; but it is difficult to ensure a thorough purity of the air of a building by this quiet method whilst human beings are inside. Perflation is the term used for the swifter movement of air caused by opening widely doors and windows, whereby draughts are produced. Injurious vapours are also given off from the skin, from lighted gas and candles, fires, waste scraps of food, dust, and dirt from boots and clothes. Hence walls, ceiling, floor, and furniture should be cleaned from time to time.

Again, drains, dust-bins, and out-houses should also be kept clean and in good order. The drains should be well flushed with water. Dust-bins should be cleared at least once a week. Moreover, it is wise to let a clever surveyor look over a house now and again, so as to correct any fault which may have arisen in connection therewith.

Bees do not deposit their ash in the hive, except when the winter cold is unduly long, and the bees are therefore unable to leave the hive. In this case dysentery breaks out. Similarly, the parents of birds remove from the nest the excreta of the young. If a snail or slug enter a hive the bees will kill it, and either remove it from the hive, or else cover it with wax, and seal it down to the surface on which it is crawling. Honey bees will even form groups, and flap their wings, so as to cause ventilation of the hive, if needful.

Moisture and emanations from the soil may be prevented from entering the home by raising the ground floor two feet or more above the soil, the space between the floor and the soil being freely ventilated, or by covering the ground with tar paving, mineral asphalt, or concrete and cement.

Soil contains a great amount of air, consisting largely of vapours produced by decomposition of organic matter in it, and this air is in continuous movement. If one goes down a mine, strong currents of air come from the cut surfaces of the shafts. This is produced by pressure of the atmosphere on the soil. If this air, thus passing through the soil in currents, just as through the atmosphere itself, comes into contact with a cemetery, or sewage, or other decomposing material, it becomes contaminated by the foul vapours being driven along with it. These will tend to escape where the pressure of the air is reduced, as it is reduced at those sites on which houses have been built, if the sites have not been specially protected, all the more so because they are heated. If a tube open at both ends be driven into the soil, and one blows into it, there is not much more resistance than when one blows into the same tube held in the air, because the soil takes the gases into its interstices nearly as readily as the atmosphere does.

The moisture of the soil, as well as the gases of it, must be prevented from rising in the walls of a house, by placing into these a so-called damp-proof course, made of mineral asphalt or the like material, a few inches above the soil and a few inches below the ground floor. Again, the walls must not permit of wind-driven rain soaking through. The roof must be sound, and the spouts and drains should be constructed so as to effectually carry off the rain.

For the purpose of perflation, all windows should extend as near to the ceiling and the floor as possible, be easily openable, and be effectual when opened in causing a strong current. The hall, or staircase-well, should have openings in the walls or doors, to allow entrance and exit of air, and there should be one or more pipes extending from the ceiling upwards to above the roof, the outer opening of each pipe being fitted with a fixed cowl. Each room should have openings for admission and for escape of air. The lower sash of each window may be raised a few inches, and the opening fitted by a board, so that air can enter.

Openings for escape of air may be by holes in the wall near the ceilings, with hoods opening downwards over them, so as to avoid draughts and rain.

All indoor drains must be as short as possible, and open freely in an exposed manner into sinks close to one of the outer walls through which the pipe is to be taken. The sink-pipes must not open directly into a covered drain or receptacle, but in the open air over a short impervious gutter, which last may discharge through a proper trap into an underground drain. Cleanliness round the home is necessary for the sake of good air, and to prevent flies bringing infection into the house and on to the food.

All water used for drinking should be at first filtered and then boiled. Boil or thoroughly scald all milk to be used. Either a Jeffery or Pasteur-Chamberland filter is advised. If charcoal filters are used, the charcoal should be frequently cleaned or renewed. Boil water in Australia to prevent hydatid disease. Cisterns ought to be thoroughly cleansed every three months, or after leaving a house when one returns to it, all accumulations being very carefully removed, as they contaminate the water.

Ventilation is most necessary, and is, indeed, now as well managed as drainage. Rooms are now generally higher than was formerly usual, so that one has not to stoop when passing to and fro. They also not only contain more air on account of greater size, but also, usually, in this country at least, have fireplaces provided with open chimneys, whereby an efficient means of escape of vitiated air is supplied. There are also furnished the warmth and light that are necessary.

In this connection we may say that objections may be urged against stoves. There can be no better method of keeping a room warm, and at the same time well ventilated, than the use of an open fireplace and chimney. Of course other measures are necessary in order to ventilate a house well, and it may be remarked here also that a house, after being built, should be well dried with fires, for the first six months.

Another point is that there should be a sufficient number of large windows in every house. It is very important that rooms should be light and also well ventilated, so as to be open to the cheering effect of the bright sunlight, the most powerful disinfectant in the world. The roofs and floors should be well seen to, so that water cannot gain entrance. If any damage to a building occurs, it should be well repaired by skilful workmen.

The modern liking for one-storey buildings or bungalows has some disadvantages connected with it, one being that, if there be any noxious vapours arising near the ground, the inmates are more directly exposed thereto than if at a higher level, at which they breathe a stratum of purer air. So many accidents in descending stairs occur, that the wisdom, and indeed necessity, of having efficient handrails is obvious.

Chapter VIII.

NUTRITION.—FOODS.

Some actions may be apparently entirely advantageous to an individual, but still distinctly opposed to the welfare of other human beings ; but the actions beneficial for self and those beneficial for others are not always in antagonism, though they may often be so. On the other hand, it frequently happens that deeds done for purely selfish purposes may really redound greatly to the benefit of the race. Actions of this kind which are primarily and directly beneficial are mainly those needful for care of self, for self-preservation. Clearly there are some obvious requisites for the maintenance of life, such as fresh air, food, water, and in the case of civilized human beings, clothing and a certain amount of shelter, as mentioned in the preceding chapter, to protect from inclement weather, and to preserve the heat of the body during the time passed in sleep at night. As a rule, for ordinarily-gifted persons, the securing of these essentials can be achieved without any infringement of the rights and privileges of others ; and as for air, it is free to all in a wider sense than any other fundamental need.

Now we cannot blind ourselves with the notion that the daily habits of civilized life are in all respects better from a sanitary point of view than those pursued by savages. There can be no question that the latter live a far healthier life in regard to fresh air and to sunlight, and no doubt their frequently greater hardihood is due to advantages gained in these matters. Sometimes also they may drink a purer water than is always usual in the case of denizens of cities. In regard to food, however, they incur several risks greater perhaps than we need incur—because they are not so scrupulous in cooking, as we ought to be, and generally nowadays are.

Perhaps no group of human beings lives entirely on uncooked or unprepared food. The men in savage tribes roast, whilst the women boil, food. Quick roasting with a brisk fire renders the salts of the meat-juices available. In order to carry out boiling, women invented the potter's art, using clay for making utensils. Boiling is effected in vessels of wood, wicker—i.e., bamboo or cane—baskets lined with clay, stone and clay, or stones only.

Cattle-breeders discovered how to abstract blood, without killing the animal from which it was obtained. Dairy-farming also became customary ; and at length came the baking of bread. Fire is known to all varieties of mankind, and the lowest races obtain it at this day by boring or rubbing together two pieces of wood which differ in degree of

hardness. Wood-pulp becomes alight, and this fire is communicated to tinder. The Polynesians, Malays, and Negroes of East Africa rub a polished piece of hard wood in a groove. The Esquimaux and certain Siberian tribes bore with an arrangement like a turner's bow. Fire is obtained by concussion in Tierra del Fuego and elsewhere, and other tribes use steel for the purpose. Australian native women often carry a glowing firebrand in hand. Fire is lent to one another. A box of matches is highly valued by lower tribes. (Dr. Haberlandt.)

Further, it is at least questionable if it is judicious to select for food only the muscular tissues of animals, and to reject most of the organs as is sometimes done, for these latter, doubtless, contain valuable substances. No doubt, vegetarian diet may be healthful at times, and for certain persons ; but, when animal food is indulged in, it may occasionally be wise to consider if the organs are not also useful food, as well as the muscles. However this may be, it is at least clear that the nature, quality, amount, and preparation of all kinds of foods need great care. No doubt, in the general way, it is the case that the articles of diet consumed nowadays are of fairly good kind, as compared with those our predecessors subsisted on ; and, probably, some are scarcely so much adulterated as was the case before the severe penalties for such practices were exacted. There is greater vigilance, too, in seeing that the law on this matter is carried out ; though still there is more to be done. The preparation of food for the table is accomplished with greater skill, and, indeed, it may be said that cooking is recognized as an art requiring training, knowledge, and practice, and one which has made remarkable progress during the last century. The making of bread has advanced considerably. White bread is good and nutritious, but wholemeal bread is perhaps better for the weak and for children. As for Italian pastes, e.g., macaroni, they are very nutritious, but not very easily digestible.

Thorough cooking is essential, because the parasites and germs which may be in or on the food are destroyed by the heat ; but we must at the same time note that the ferments and other beneficial substances are also entirely altered—often, doubtless, for the worse. The ferments are useful for aiding digestion, and the other substances for imparting vigour ; but these losses are counterbalanced by the above security.

This is but one example of the well-known fact that there can be no conceivable advantage without some drawback attached to it. On the whole, it is very probable that we gain far more by cooking than we lose, for, doubtless, we thereby escape some fatal and terrible diseases and parasites. Most people are not sufficiently alert and careful, and many err through sheer want of knowledge. It is no uncommon thing for instance to see tapeworms in fish eaten quite inadvertently by those who do not recognize them. The writer has seen this done ; but it is only fair to add that it is quite possible no harm results, and " where ignorance is bliss, it is folly to be wise." However, it is just possible there may be a connection between the tapeworms of fish and leprosy in some of those who live mainly on

imperfectly-cured fish. The *Bothriocephalus latus* is a tapeworm got by man from fish, largely such as is obtained from the Baltic Sea.

Parasites are indeed not so very infrequently met with. For instance, pork may give rise to trichiniasis, and the *Trichina spiralis* is the small threadlike worm which causes it. This is coiled up in minute ovoid cysts within the muscle-fibres. Each cyst contains one immature worm, which is set free when the gastric juice dissolves the capsule or cyst-wall. Trichinæ are chiefly found in pork ; but are also liable to occur in the flesh of rabbits, rats, cats, and mice. Flesh containing the worms looks speckled, and if a thin section be steeped for a few minutes in liquor potassæ, the coiled worms can be seen under the microscope. All the flesh of infected animals should be destroyed.

Dr. Zenker, of Dresden, in the year 1860, discovered that the painful symptoms and terrible mortality of trichiniasis were due to the presence of young trichina worms. These worms are hatched in the intestines of people who have eaten pork infested with the eggs of the worms. They then burrow through the muscles to all parts of the body. One cubic inch of pork, it has been found, may contain 100,000 trichinæ, and Dr. Thudichum calculated that there were 28,000,000 of young worms in the muscles of a patient whom he examined. The infection often first manifests itself by violent vomiting and diarrhœa, followed by high fever, with severe pains in the limbs, back, and head. About the seventh or eighth day of the disease, a peculiar dropsical swelling of the eyelids and root of the nose appears.

No pork should be eaten, unless it has been thoroughly cooked. Even a very minute portion of the inmost part of a ham, which escapes being heated nearly to the boiling point of water, may convey several living trichinæ into the stomach of a person who eats it, and thus give rise to this painful and frequently fatal disease.

The *Tænia solium* of man is the adult worm springing from the *Cysticercus cellulosæ* of the pig. This exists in the form of cysts as large as a small pea embedded in the muscles, both voluntary and involuntary, and various organs, but not in the fat. Carcasses, hams, and bacons, infected with these cysts, should be destroyed. Meat cooked at 150° F. changes from red to brown, and, if it be kept for some time thus heated, the eggs or young of tapeworms and trichinæ are killed.

The eggs of tapeworms and other worms may be ingested by means of salads, celery, cucumbers, or other vegetables, uncooked and not thoroughly washed, and hence unwashed and uncooked salads, vegetables, and fruits should not be eaten.

Distoma hepaticum, the liver fluke, is often present in the liver of sheep, and a few may be in healthy animals. If in great quantity, they cause jaundice, dropsy, diarrhœa, loss of hair, and emaciation, constituting "sheep-rot." They are especially found in wet localities and weather, the eggs and embryoes being developed in water. If there is emaciation, the carcass should be destroyed.

Food, of course, should be of good quality, and a sufficient but not

too great amount should be taken. It is no doubt true that some eat too much ; and it has been said that many consume nearly twice as much proteid material as is really required. Some people would do well to refrain from too completely satisfying an inordinate appetite, especially at one meal ; but, on the other hand, there are not a few who really eat too little. One modern idea is to advise for some invalids somewhat large amounts of food ; and the authors can testify from personal experience and observation that, if there be plenty of good fresh air, great benefit is derived from a liberal diet by many, especially those suffering from consumption and neurasthenia.

Another suggestion is that food should be frequently varied, so as to give the system diverse materials for assimilation. Also, if there be any special dishes which do not suit one's digestive powers, these should be crossed off the list. Most people, indeed, should be careful as to lobster salad, crabs, oysters, rich pastry, plum puddings and sweets, corned beef, raw and also hard-boiled eggs, pork, cucumber, and celery. High game is also not to be advised, nor, in some cases, especially if there be indigestion, is it a safe food. It is important to bear in mind that people can carry and convey to others the bacilli of disease, without even being themselves ill. Hence, there is risk of infection, if food be handled, or dealt with in an uncleanly fashion.

It is said that one twenty-fourth of the body wastes daily, i.e., at the rate of over a ton in a year for an average male adult.

When one is from one to twenty-five years old, as much good food may be taken as is desired ; from twenty-five to thirty-five, as much as suffices to keep the body at its correct weight for height ; from fifty-five to seventy-five, a little less of simpler kinds of foods.

Many harmful anaerobic bacteria, as well as those of tetanus, are liable to be present in manured garden soil, and these may cling to vegetables, and fruits such as strawberries, and may be ingested with them. In theory, no unsterilized food should be taken. Hence, not only should other kinds of food be always cooked, or boiled, and milk boiled, but vegetables and fruits also should be as a rule boiled, especially such as lie in contact with or near to the ground. Even the ingredients of salads, e.g., radishes, tomatoes, lettuce, endive, onions, beetroot, should be at least scalded, if not boiled. Potatoes, artichokes, cabbages, cauliflower, Brussels sprouts, asparagus, are, of course, generally boiled, or at least cooked in an adequate way ; but tomatoes and fruits are often eaten raw. Strawberries, which are in close contiguity with the garden-mould, are, as above said, liable to be contaminated by manure, and should really be boiled, or at least dipped in boiling water ; and so also should other fruits, such as cherries, plums, apricots, peaches, and apples, which are liable to be subjected to the pecks of birds, which may have flown directly from a manure heap to them. It is best that apples should be roasted, or cooked in pies, and, as a rule, wisest to eat fruits in the form of preserves, since otherwise they are liable to carry parasites or their ova, or germs of diseases. Not only are internal and external parasites directly injurious ; but they also

aid germs of disease to gain entry into the system through their bites into the tissues of the intestinal wall (Metchnikoff). It is probable that appendicitis and typhoid fever may sometimes arise in this way; and it is said that a septicæmia of anthropoid and lower apes is caused by the *Bacillus coli* which enters through wounds made by worms adhering to the intestines. Further, cancer of the bowels is a very general cause of death in the old. In the decade 1891 to 1900 pneumonia produced an annual death-rate of 9,089 per million, whilst cancer produced 12,201 per million. By far the commonest site of cancer is the stomach, if we except the breast and uterus of females, and next to it come the liver and gall-bladder up to the age of eighty-five years. After this age the uterus is still most generally affected in women, the skin becoming more often attacked in men; but, with these exceptions, the stomach and liver are the most frequent seats.

In regard to causation, cancer may be due to some animal microbes of a plasmodic nature; but it seems certain that it is brought on by irritation, as e.g., by that of a clay or other pipe on the lip, or by that of stones in the gall-bladder, or by hard particles of food in the stomach and bowels. The obvious inference is that one should lessen the irritation of the stomach and liver as much as possible. Stomach-irritation may be lessened by slowly and thoroughly comminuting the food before swallowing it, and irritation of the liver may be diminished, partly at any rate, by taking a sufficient and rather large amount of fluid daily.

In women, the cases of cancer of the liver are in the ratio of three to two in men above fifty-five years, and this greater proportion may be put down to their more sedentary lives, and also to the habit common in women of taking an insufficient quantity of fluids, whereby the bile is secreted thickly, and may give rise to the formation of gall-stones, which, as above said, by their irritation cause the development of cancer of the liver.

Many people do not well masticate food. Eating should be deliberately carried out. Hard or large particles should not enter the stomach, especially of the young and weak. Such unchewed portions may be retained, whereby heartburn, or vomiting, or both, may be occasioned. Insufficient mastication is a commoner fault in men, and hence more cancer of the stomach occurs in them than in women of fifty-five years, the numbers being 3,244 and 2,967; whilst at sixty-five years they were 2,965 and 2,917. At higher ages more men are affected in that way.

Decay of teeth often causes the habit of swallowing the food imperfectly comminuted, which is unfortunately becoming rather general in these days of hurry. Bad teeth and such bolting of food are doubtless connected. Large and unsuitable morsels are ingested into the stomach, and one or more of these may cause irritation and inflammation in the pylorus, duodenum, and other parts. Another locality where irritation is likely to occur is in or near the cæcum, where the intestinal contents have to ascend. At the point where

they turn the corner of the bowel, great pressure must be exerted against the appendix by the on-coming material.

In the animal creation the appendix gradually dwindles in size, until in man its lumen is very small, wherefrom it results that portions of hard material, which might have been unable to irritate a larger cavity, may set up acute disturbance in the smaller one.

A great many people, whose teeth have decayed, possess stumps which are tender, and cause great pain, if used in mastication. When possible, these should be extracted, as they are liable to be very harmful. In short, the condition of the teeth should be seen to, and if they be defective, a skilful dentist's services be sought, so that those that are decayed may be either effectively stopped or extracted. Whether artificial teeth be obtained is a point for each person to decide, as they are not so much desirable for purposes of mastication perhaps as for appearance. If the teeth be absent, or so bad as to be unusable, all solid food should be cut or ground into small pieces before being taken into the mouth, wherein they should be retained for some time, being moved about by the tongue so as to be well mixed with the saliva. It has been discovered that the ancient Egyptians skilfully used gold in dental work and fittings.

Eating should be slowly carried out, and at leisure, and there should be an absence of anxiety and mind-strain at meals. A moderate amount of food should be consumed, and the stomach should not be overfilled at any one time. One's weight should be not exceeded or diminished by half a stone over or below that which is correct for the height. If there be any need for watchfulness, the body should be weighed weekly ; or, when the need is less, once in a fortnight or a month.

After a meal, especially if it be heavy, time for digestion should be allowed, say half an hour before any serious mental or bodily work be begun. Indeed, no exertion or anxiety should be undertaken just before, during, or after a full repast ; and in sanatoria it is sometimes directed that the patients should recline at rest for half an hour before each meal.

Hunter fed two dogs equally, and took one out to run after a hare, whilst the other was allowed to lie down and sleep. At the end of an hour both dogs were killed, when the food in the first dog's stomach was found to be unaltered, whilst in the case of the second dog the food was nearly digested, and most of it had passed into the intestine.

A balance betwixt waste and repair must be maintained. A person may be losing flesh without any marked suffering, and even without being aware of it. There will, however, usually be a pallor of the skin —especially that of the cheeks, though there be no loss of cheerfulness, nor of appetite, nor of agility, nor of power of digestion. Indeed, all the functions may apparently be natural. In such cases an alteration in the food should be made in accordance with the special needs of the case, and any weakening habits should be given up. Sometimes aerated bread may be serviceable. Gentle outdoor exercise should be taken :

but a great part of the day should be devoted to repose. Good air should be ensured, and, so far as possible, a window remain open in the room occupied both during the day and the night. Perhaps the medical attendant may prescribe cod-liver oil, or some preparation of iron, together with a bitter tonic, and an occasional aperient when required.

Food.—It is not easy to give a very satisfactory definition of the word food ; but it may be said to be a word really applicable to all substances, gaseous, liquid, or solid, which, after being taken into the body of an organism, help in building fresh tissues, or restoring wasted ones, or furnish heat and energy. In this connection it may be pointed out that foods, as a rule, furnish materials for the whole body, and not for given isolated portions or tissues. The nervous structures of an animal contain much organic phosphorus, the bones a large amount of phosphate of calcium, the muscles much nitrogenous tissue (myosin, etc.), and all these are contained in a well-arranged diet. Roughly speaking, to put the matter in a tabular form, a food does two main things, viz., it is used for :—

1. Building-up or repairing tissue.
2. Supplying material for heat or work.

In other words, it is either a tissue-former or a means of energy. Tea, coffee, and the extractives of meat are not really foods.

Nutritive constituents are :—

(i) ORGANIC :—

(*a*) *Nitrogenous* { Proteids, e.g., myosin of meat, casein of milk. / Albuminoids, e.g., gelatin.

(*b*) *Non-nitrogenous* { Carbohydrates, e.g., sugars, starch. / Fats, e.g., butter.

(ii) INORGANIC { Water. / Mineral matters, e.g., Na, K, Ca, Mg, Fe, P, Cl, S.

Building material is supplied by the proteids, water, and minerals.

We extract here a few notes from a work on "Diet and Dietetics," by A. Gautier (translated by A. T. Rice-Oxley).

The albuminous substances, which, combined with water and some salts, compose in a young animal almost the whole weight of its tissues, form the great complex family of albuminoid or proteid matters. The word albuminoid springs from the fact that they have the general properties of the principal material of the white of egg or albumen.

All the albuminoid or proteid principles of the young cell and of its nucleus contain the elements C, H, O, N, S, P, and more rarely I or Fe. These protoplasmic albuminoids are generally amorphous, incapable of dialysis, and of an internal asymmetric texture, for they all act on polarized light. They can act both as bases and as very feeble acids. They are capable of hydrolysis, i.e., of dividing while taking up water, under the action of acids diluted with water, of bases, of acids, ferments, etc. Owing to this hydration, after having given a series of phosphorated derivatives, material for the "nucleus" and intermediary substances, they are transformed into complex amides, e.g., leucin,

tyrosin, oxamide, aurin, glycocoll, urea, and others, which we find in most of our tumours and tissues.

Other more simple albuminoids, e.g., the albumen of egg, do not contain phosphorus. These may proceed from the preceding, or from alimentary substances.

The "proteid bodies," or "protein," include all the nitrogenous compounds which contain the elements C, H, O, N, S, such as the simpler albuminoids, e.g., the white of eggs, and also those which contain P as well. With the albuminoids there are associated in the animal cells fats resulting from the union of fatty acids with an alcohol, glycerin, carbohydrates like starch and sugar, glycogen, glucose, inosit, or muscle sugar.

Albuminoid substances, both those which do, and those which do not, contain phosphorus, are not free in the cells ; but are united with water and different salts, most especially with phosphates of potash, magnesia, and lime. The cellular elements of each tissue are situated, so to speak, in an interstitial humour of lymphatic or sanguineous origin, which receives the products of organs, and brings to each cell the nutritive principles.

Fats, carbohydrates, and albuminoids cannot form tissue. For production of heat fat is best, as it necessitates the greatest degree of oxidation. Proteids, carbohydrates, and albuminoids are about equal to one another as heat producers, but scarcely half as valuable in this respect as fats. It is for this reason that the Esquimaux eat so much fat. The fact that the milk of the walrus contains 40 per cent of fat is also noteworthy.

For muscular energy the carbohydrates stand first, and proteids and fats and possibly albuminoids are also good in this respect. Sugar, too, is very useful as a muscle-food, provided it be supplemented by proteids, which last build up and repair the tissues, and supply heat and pabulum to the muscles. The following standard diet is suggested by Oliver :—

Foundation.—Bread 1 lb., meat ½ lb., fat ¼ lb.

Accessories.—Potatoes 1 lb., milk ½ pint, eggs 2, cheese 2 oz.

Factors Modifying Amount and Kind of Food Requisite :—

1. *Age and Sex.*—Children need more building materials, fuel, and muscle food—in general, a large quantity, and especially of proteids and fats.

The ratio of food required by a woman to that needed by a man is as 8 to 10.

2. *Height and Build.*—Heavy persons obviously require more food than lighter ones, in order to keep up the larger bulk. Again, the greater the extent of body-surface, the greater is the radiation of heat, and hence more fuel is needed. Therefore, tall, thin persons want more food in proportion to weight than short stout ones.

3. *Work and Rest.*—The more work done, of course the more food is requisite. The amount of labour performed is in direct correspondence

with the quantity of food needed. For brain-workers especially, the quality should be good, and the digestibility easy.

4. *Climate.*—For cold countries and seasons more clothing is needed. Also the fuel-foods, especially those rich in fat, should be in greater amount. For hot countries the carbohydrates should be in greater quantity, and the proteids and fat be less. As above hinted, the inhabitants of cold regions require more fat than those of torrid zones, because fats and oils enable one to stand cold. Esquimaux live largely on blubber, whilst on the other hand Hindus consume much rice.

5. Personal peculiarities, such as those of weight and shape and different powers of digestion, should also be considered when framing a dietary.

6. Certain special requisites may be also mentioned. As an example may be given the need for laxatives, such as stewed prunes, figs, and roast apples for the costive. Some dishes disagree with certain individual persons.

If we believe that man is descended originally from marine animals, the constant presence of the salines of sea-water in that environment may be a noteworthy point, and explain the use of those salines in therapeutics.

In North America deer and other animals resort for hundreds of miles to the salt "licks," in spite of all the dangers which beset them, because they must have salt in their blood. Still, some people hold that we ought not to eat any salt; but in this contention they are probably wrong. Again, any one who has watched the avidity with which laying hens will swallow fragments of eggshells, will not be so much surprised as he otherwise might be, when he reflects that hens must have lime in their blood from which to furnish those coverings of their eggs.

The Effects of Eating Impure Food. The *Bacillus enteritidis sporogenes* is met with in unsound meat and flesh. Flesh which is not very nutritious is not of necessity actually dangerous. Decomposing flesh, or that of animals affected with disease or parasites, may produce gastro-intestinal irritation with diarrhœa, vomiting, and colic, followed by prostration, pyrexia, and heart-failure. Beef, or pork-pies and sausages, have caused such conditions. Pork when cooked contains more gelatin than any other adult flesh; and young meat, such as veal and lamb, also contains much. Hence, gelatin being a favourable medium for the growth of pathogenic bacilli, special care in regard to thorough cooking and cleanliness should be taken in regard to pork and young meat. Dr. Ballard says that in meat which is capable of producing disease in those who consume it, there may be one or both of: (1) Living organisms; (2) An organic substance produced by the first, which causes the morbid phenomena. Different kinds of bacteria may, apparently, by producing this poisonous material, either outside or in the body after ingestion, cause similar results, either at once or after a time. A typical case was that of five persons, who, after consuming cooked salt fish and pig's cheek, obtained from a stall in a low quarter

of Liverpool, were ill. Four died the next day, and the other, two days after that day. After death signs of rapid and intense inflammation were seen, and in three of the cases the *Bacillus enteritidis sporogenes* was found.

Preservatives.—Very useful effects can be gained by cold, and also, in the case of tinned foods, by heat; but chemical preservatives are frequently harmful, both by making digestion difficult, and also in other ways. The chief substances employed for preserving food are boric acid and borates, salicylic acid and salicylates, formalin, salt and saltpetre. Boric acid is used for margarine, butter, hams and bacon, fish, cream and milk. In butter and margarine there may be as much as 30 grs. to the pound. It is chiefly on the outside of hams and bacon: but even in the interior as much as 6 grs. to the pound may be present; and it is also used in making sausages, pork pies, and pastry.

Salicylic acid and salicylates are added to jams. Both boric and salicylic acids are sometimes used for British wines and temperance drinks.

Formalin is added to milk and cream, especially in the winter. Professor Boyce has shown that kittens fed on milk containing boric acid and formalin became ill and emaciated, and even died, if as much were present as 10 grs. of boric acid to the pint.

Colouring Matters.—Red sausages have gained their colour from a mixture of borax and red coal-tar dye called sulphonated diazol, with salt, or saltpetre.

Armenian bole consists of oxide of iron with a little silicious matter.

Smokene is composed of borax, salt, red coal-tar dye, and creosote, and is brushed over hams, bacon, fish, to give the look of having been smoked.

Foods.

We now proceed to give some notes respecting certain animals, vegetables, and other substances used for food. The list is merely a cursory and incomplete sketch, but it is hoped it may be useful.

Firstly, we have to consider the Animal World.

The remains of man's hunting spoils are the proofs of his earliest presence on the earth. Numerous tribes accustom animals to herd together near them, and this practice developed into cattle-breeding, which is carried out by Kaffirs, East African shepherds, and some Polar families. Thus hunting and fishing was followed by cattle-breeding, which supplied meat, milk, and blood. Tribes which depend on hunting exclusively, e.g., the Austral Negroes, and the inhabitants of the Andaman Islands and Tierra del Fuego, are not able to migrate, and are lowly developed. Tribes, which fish, follow the streams, and so wander far, and hunt freely as well. Tribes, which breed cattle, wander freely to secure fresh pastures, and they gain in intellect and resource. The absence of tameable animals from the Western Hemisphere has had a retarding effect in regard to civilization in that part of the world. (Dr. Haberlandt.)

According to Dr. Russell Chittenden, as we gather from his work on "The Nutrition of Man" (Heinemann), human beings do not need much proteid food, and indeed do better work without it. Most of what we habitually consume does not form part of the bioplasm at all, being excreted as urea. All that is needed can be derived from vegetable foods. The amount of urea is not increased by exercise. Proteids are not the source of energy, which comes from the oxidation of carbohydrates and fat.

According to Dr. Harry Campbell, man's simian ancestor was largely frugivorous, but also consumed a little animal food. When man began to hunt and fish, he greatly increased the latter. The next step was careful preparation of food. The third step was the breeding of animals, and the cultivation of vegetables for food. During the early hunting period man probably became more carnivorous than vegetarian. Perhaps some vegetable food should be eaten raw, and cooked farinaceous food should be in a form requiring mastication. Wild honey was the sole source of pure sugar for primitive man ; but now thousands of tons of sugar are yearly extracted from sugar-cane and beetroot. Starch, sugar, animal food, each should be temperately used.

Here we may classify foods, or rather requisites of the body :—

1. Proteins, fats, and carbohydrates.
2. Flesh-extractives, vegetable alkaloids, glucosides, ethereal oils, condiments or aromatics, etc.
3. Inorganic constituents, S, P, Cl, K, Na, Ca, Mg, Fe, Si, Mn, I, As, H_2O.

If one of these be entirely excluded, an animal rapidly loses ground. An average *man*, doing little or no heavy work, needs daily about :— Albuminoids 107 grams, fats 65 grams, sugar or starch 407, about one-fifth of the last being replaceable by half its weight of alcohol. The average woman needs about four-fifths of the above per day, viz., albuminoids 86, fats 52, and carbohydrates 326 grams.

Yet perhaps the needs of the body for proteid may be fully met by about half the amount usually consumed, and the additional amount brings certain penalties and disabilities. It is found that the energy of muscle-work comes preferably from non-nitrogenous matters, and, hence, there is no necessity for additional proteid in connection with increase of muscle-work. Although proteid, either animal or vegetable, is requisite to some extent, it is noteworthy that proteids are not completely oxidized in the body into simple gaseous products like the non-nitrogenous foods are, but leave solid oxidation-products, which are liable to produce gastro-intestinal disorder, indigestion, intestinal toxæmia, liver troubles, and gouty and rheumatic conditions of the body.

The proteid required has hence been cut down to about 0·85 gram per kilogram of body-weight. Thus, by a man who weighs 70 kilos, or 154 lbs., or 11 stones, 59·5 or, say 60 grams, of proteid are needed, and this can be got from about ½ lb. of loin steak, lean lamb, veal, or poultry flesh, or of dried peas or beans, almonds or pine nuts, or cheese, though more may be required, on account of defective digestibility, of any one

article by a given person. If, however, a similar man had to depend entirely on lean beef, as much as 4½ lbs. would be needed, i.e., nine times as much proteid as in the former case wherein carbohydrates and fats were also taken. On the other hand, in the case of certain vegetable foods, e.g., flaked rice, crackers, and shredded wheat, all three elements, viz., proteid, carbohydrate, and fat, are present in such proportion that the energy-requirement would be supplied by the same quantity as supplied the necessary proteid. Better still are such general combinations as wheat bread with butter or fat bacon, shredded wheat with rice cream, crackers with cheese, bread and milk, eggs and bacon, meat and potatoes.

Animals like dogs cannot exist for long on a low proteid diet, which occasions a loss of power of absorbing from the intestinal tract, probably owing to changes in the epithelial cells, and to a diminished out-pour of the various digestive secretions. Human beings, however, are naturally omnivorous, and consume only small quantities of proteids. They can endure for a time even large reductions in the amount; but if these be long continued, there will be shown at last some of the disastrous results produced in dogs. Still, it is true that the usual amount consumed is too large, and experiments with athletes and soldiers have shown the benefits resulting, from a diet containing less proteid, in greater muscular strength, and the diminution of muscle-weariness after exertion.

However, human beings have always obtained the nourishment needed from the three kingdoms, animal, vegetable, and mineral. Though the denizens of Lapland and Greenland feed almost entirely on the flesh and fat of fish, seals, and cetacea, yet the little vegetable and terrestrial animal food which the scanty herbage of those polar regions supplies, and even the contents of antelopes' stomachs, are much prized. Similarly, the negro, whilst living mainly on the fruits and roots of tropical forests, values highly as food the game, or rare animals, domesticated and other, which can be found in the Torrid Zone. An animal consists of compounds of a great variety of elements, such as hydrogen, fluorine, chlorine, bromine, iodine, oxygen, sulphur, nitrogen, phosphorus, arsenic, carbon, silicon, potassium, sodium, calcium, magnesium, iron, copper, manganese, aluminium, boron, and vanadium; and it is obvious that all these necessary elements can only be gained by taking a great variety of food.

Carnivorous animals possess the power of transforming a fair amount of their nitrogenous food into ammonia, and so keeping their blood alkaline. Man has this power only to a small extent, and hence needs vegetable food in addition. It is true that the herbivorous man, or present-day vegetarian, can live solely on vegetables; but he must take a quantity, of which much is not used up in alimentation. As above said, speaking generally, meat is eaten by almost all nations, and nearly every variety of mankind. Though, however, man is omnivorous by nature, human beings can live and flourish without meat, and cannot be nourished by meat alone. If they ate larger

quantities of cereals and less of meat, it would be a healthier and less expensive course. Probably meats will not be so much used in the future. The price of flour or maize is only one-eighth that of meat, and the whole of it is useful as food, whereas only about half of the meat is so. Hence cereals and other vegetable products are superior as foods. A cereal is almost a complete food ; whilst meat is only a partial food, and far more costly. The eating of a large quantity of meat is often merely a habit.

Insecta.—Insects and other similar animals of every kind are devoured with avidity by some of the savage races. For example, the Austral-Negroes are nomad hunters, who use as food every living species, including all kinds of fish, the kangaroo, and the beetle chrysalis. Their dogs, or dingoes, are used both for hunting and food. Not only insects but maggots, shell-fish, and even reptiles are devoured. Their animal food is obtained by the men ; and the women toil in wood and steppe, digging with sticks for edible roots which, with fruits and seeds, are roasted and eaten. The grains of wild rice, and other cereals, are collected, and made into flour, which is baked into bread; but there are only traces of agricultural cultivation. The food is cooked over an open fire. In times of drought they migrate to lower-lying localities.

These Austral-Negroes are cannibals, consuming human flesh, especially when food is scarce. Amongst the tribes of the interior of Central Australia, even the dead bodies of relatives are consumed.

The most familiar example, however, of an insect used for food is the locust. These are consumed in all the parts which they frequent, and in some places are really important articles of diet. Herodotus refers to the Libyans as drying locusts in the sun, powdering them, and adding the powder to milk which they drink. This very same practice is now carried out by the Bosjesmans of South Africa, who, on observing an approaching cloud of locusts, make great fires, to which they add many green bushes so as to make smoke to suffocate the creatures. These then fall to the ground and are collected, and some are eaten. The rest are dried and pulverised, and the powder is kept, and, when required for food, mixed with water or milk. Harmless and stingless as locusts are, they are a source of fear to the camels. They are even prayed for in Arabia. When boiled or fried, they are said to be a dainty food, and taste not unlike shrimps. In Palestine they are roasted, or boiled in salt water ; or else, as above described, they are dried in the sun, their heads, wings, and legs plucked off, and bodies ground into powder. The bitter flavour is corrected by mixing the dust with camels' milk, or with honey, as eaten by St. John the Baptist. This locust-dust, mixed with honey, is an ordinary food, especially of people living at a distance from towns.

Arachnida.—At the present time many people eat with avidity cheese-mites ; some doing so inadvertently, and some purposely.

Cœlenterata and Echinodermata.—The ovaries of sea-urchins, the ducts of some actiniæ (sea-anemones), and certain medusæ are sometimes eaten. They are rich in phosphorus, and organic bromine and iodine.

Mollusca.—Many kinds of molluscs are used as food, including oysters, mussels, scollops, cockles, periwinkles, whelks, limpets, clams, edible snails, and sea-slugs.

Oysters, especially if swallowed raw, are very easily digested, being formed of very assimilable albuminoids, accompanied by phosphorated fatty matters and glycogen. They are not, however, very nutritious, because they contain much water, and it is said that ten dozen would be required to supply the nitrogenous matter daily needed by an average man. Moreover, if taken from the mouths of rivers, estuaries, or basins into which drains discharge, they, in common with other shell-fish, may be the channel of communication of the typhoid bacillus, and, indeed, are more dangerous in this respect than some, e.g. cockles, which are boiled before being eaten. Oysters, mussels, and snails contain a kind of glycogen. Oysters, mussels, and cockles are said to be light aliments suitable for diabetics.

The mussel is a mollusc which is found in many parts of Great Britain, and in nearly all parts of the United States, and elsewhere. The shell is smoother than that of the oyster. Inside the shell, pearls, which are really composed of carbonate of lime, are often found, and this fact constitutes their chief value, for their flesh is not palatable or valuable. The mussels of Wisconsin are especially noted for containing pearls, which are more generally found in mussels than in oysters. (*Vide* Dr. H. W. Wiley's book on "Foods.")

Both mussels and crustacea may occasion nettlerash (a kind of urticaria), nausea, and diarrhœa in those who consume them. Mussels sometimes produce toxic symptoms, especially if eaten between May and September, owing to a ptomaine in the liver, mytilotoxine.

Several kinds of snails are consumed, e.g. the *Helix pomatia*, the *H. sylvatica* of South France, the *H. aspersa*, the *H. vermiculata*, the *H. variabilis*. They are eaten seasoned, as with vinegar sauce, but are rather indigestible. The ordinary edible vine or Burgundy snail, escargot (*H. pomatia*), is collected in French vineyards, those at a high elevation and free from organic impurities being preferred, especially at the close of the winter season, when the snails have had a long partial fast. They are kept a few days to allow time for evacuation of poisonous parts of solanaceous or other plants. By cooking, the flesh is rendered firm, insipid, and not easily digestible ; but they are highly nutritious, and called the poor man's oyster. The best kinds, seasoned with aromatic herbs, are costly, and prized by Parisian gourmands.

It is, however, not only in France, but also in other countries that different kinds of snails are greatly valued for their nutrient qualities. If an ordinary garden snail be boiled, it will turn a large cupful of water to a jelly. The periwinkle is really a sea-snail. People in some parts of England eat garden snails with a view to cure consumption, in the belief that a snail eaten alive is a cure of the disease if in an early stage. In the coal-mining village of Knottingley, a few miles from Wakefield, the snail is considered (according to the *Morning Leader* of Aug. 1, 1907) such a delicacy, that a snail-famine is feared. It is said

that nearly a quarter of a million snails have been consumed there yearly for many years.

It seems that the local dispensary at Knottingley was in need of funds, so a publican offered boiled snails at six a penny to his customers, and the proceeds to the dispensary. The Yorkshire miners entered into contests as to who should eat the most snails. Other public-houses in the district followed the custom, and one raised as much as £15 per annum. A taste for boiled snails arose, and other mining villages in the district took the habit—which does not seem to be harmful. The snails are gathered from the walls and hedge-sides, and one public-house supplied 15,000 last year, so it is not strange they are now becoming scarce.

It is important to note that oysters, mussels, clams, cockles, and other marine or aquatic shell-fish, are liable to be made filthy by sewage, which they also take into their interior as food. In this way they may hold or contain the germs of typhoid fever, and perhaps some other diseases. Hence it is wise to abstain from the consumption of any which have been subjected to the possibility of being bathed by sewage. This is frequently the case, for drains discharge very commonly into rivers, estuaries, and seas, and, now that the bacterial treatment of sewage is concluded to be the best, it is probable that this plan will be continued.

It may be noted that the greenness of the green oysters imported from America is caused by copper ; but that of the Marennes oysters is not so produced, but by a special pigment.

In the *Wide World Magazine* for June, 1906, an article, entitled, " Hunting the Great Sea-slug," by D. W. O. Fagan, gives an interesting account of the " *bêche-de-mer* " industry. A few notes on this subject are collected therefrom.

Among molluscs, are placed the sea-slugs, trepangs, or bêche-de-mer fishes, including four distinct kinds, viz., the tit-fish, the black fish, the pink fish, and the red fish. Of these, the red fish sell at about £12 per ton, the black fish are worth about £20, the tit-fish £140, and the pink fish £160 per ton. The millions of Chinese consume these sea-slugs. One or other of the species are found on all coasts in the tropics ; but fishing for them is almost exclusively in the tropical seas of the South Pacific in the Eastern Hemisphere. The Californian coast is the only part of the Western Hemisphere whence a little is exported.

The tit-fish is very similar in configuration to the large black slug frequently present in gardens and fields in the spring-time in Great Britain. It is black on the back, and white underneath, has two nipples on either side of the back near the head, about 18 in. long, and about 5 in. broad where thickest. It adheres to the rock or sand beneath the water of the pools left by the tide receding from coral bank or island coast.

The red fish, unlike the other kinds, which are immobile, crawls by projections on its under surface rapidly over the rocks or sand. It looks like a large red German sausage.

The pink fish is almost confined to seas north of the Equator. It is the most valuable kind. In shape it is like the tit-fish, having similar nipples, but being of a flesh-pink hue. The dried pink trepang is bought by the wealthy Chinese. When cooked, the fish is like thick isinglass jelly, strongly tasting of phosphorus, which is thus taken into the system. Probably trepang has been eaten by the Chinese for four thousand years.

Crustacea.—Crayfish and sea-crawfish, crabs and lobsters, shrimps and prawns, make favourite and nutritious dishes for those who can digest them ; but their muscle-fibres are coarse, and not easily digested. Their flesh is phosphorated and savoury, but indigestible. Like that of the frog, the flesh of lobsters and shrimps is rich in nitrogenous matters. The flesh of the lobster is sweet, owing to the large amount of glycogen it contains, and horse-meat is the only other kind of meat which contains nearly as much.

Fish.—Fish may be divided into three kinds, so far as the quality of their flesh is concerned. These are :—

1. Those with white flesh, e.g., haddock, cod, trout, whiting, turbot, sole, brill, plaice, and flounder. They contain much water and gelatin but less than 2 per cent of fat.
2. Those with red flesh, like the salmon.
3. Those with greasy flesh, like the eel.

Fat fish, e.g. mullet, halibut, and mackerel, contain from 2·5 per cent of fat. Other fat fish, e.g. salmon, turbot, herring, and eel, contain 5 per cent. Fat fish are of about equal nutritious value to fat beef ; but they are indigestible ; whilst lean fish, having short fibres and little fat, are easily digestible. It is an error to hold that fish contain much phosphorus. Still, the flesh of fish is just as digestible and as nutritious as meat. The flavour of the kind of fish largely determines the price ; but, so far as nutriment goes, 1 lb. of cod at 3d. is equal to the same amount of sole at 1s. 6d.

The sturgeon belongs to the family of Acipenseridæ. Sturgeons are large fishes in the sea and also fresh waters of northern regions. Most of the species are anadromous, entering fresh water and ascending the streams in spring. There are two genera and twenty well-defined species, and one hundred nominal species. They are especially valuable for their roe, from which caviar is made. Fresh American sturgeon are frozen and shipped to Eastern ports. Most of the caviar made in the United States is that from the common sturgeon, and the lake sturgeon, which is found in the Great Lakes, the upper Mississippi Valley, and the Lake of the Woods.

Caviar is the salted hard roe of the sturgeon.

In regard to freshness, it may be said that fish should be firm, and that this firmness disappears in about nine hours. The eyes and skin should be bright, the gills bright red, unless dulled by ice. The smell should not be in any degree offensive. Fish keep longest if they are killed and gutted directly ; but soon spoil if, after being caught by their gills in nets, they die slowly.

On board trawlers ice or a chilling apparatus is used to preserve fish. When spawning is in progress, the fish get thin, and hence there is a close time for salmon, which varies in different parts, but usually lasts from September to February.

In the brine of herrings trimethylamine occurs in great amount.

Amphibia.—In France, Belgium, and other countries, the legs of frogs are esteemed as a delicate dish, and there really seems to be no reason why they should not be. They taste like the flesh of fowls, but are more easily digested.

Reptilia.—Ophidia.—The flesh of snakes is sometimes eaten by the very poor in some countries in the guise of eels' flesh, which in appearance it resembles, owing to the shape being cylindrical in both kinds of creature. If not sufficiently cooked, it is liable to be poisonous.

Chelonia.—The aquatic chelonia are very useful for food. All kinds of turtles, whether marine or fresh-water forms, are edible. The flesh is gelatinous, dense, and contains much fat. Their eggs, found in large nnmbers on the banks of the rivers of South America, are eaten, and are even dried and sold as a powder.

Both the turtle and terrapin can live in the water or on the land. Among the turtles, the marine kind, called the green turtle (*Chelonia mydas*), is most liked for food. Sometimes it grows so as to weigh several hundred pounds, and often to as much as fifty or one hundred pounds. It is chiefly used for soup, wherein pieces of the flesh are placed. The edible part of the green turtle is only about 22 per cent of the whole by weight.

There are several aquatic species of chelonia, the most noted being the diamond-back terrapin, which is found in the saltwater bays, lagoons, and marshes of the Atlantic coast of America from New Jersey to Texas, being especially numerous in Chesapeake Bay. Its flavour is very delicate, and this, together with the rich aroma and easy digestibility, make it very valuable for food. The terrapin is now very scarce —indeed, apparently near extinction—and expensive, and can only be afforded by the rich. It is to be hoped that artificial breeding of the terrapin may be more successful in the future than it has yet been. (*Vide* Dr. H. W. Wiley's book on "Foods and their Adulteration"—Churchill.)

Aves.—Many kinds of birds are used as food, those living on grain or vegetables being especially good. For instance, the grouse, which lives on heather, forms a very palatable dish, and if they are kept for a few days, the flavour is delicious. On the other hand, the duck, which lives on very filthy food, is also very tasty; in this point resembling the eel, which likewise consumes a not very enticing food.

Domesticated birds include the turkey, peacock, goose, fowl, guinea-fowl. Partly tame are the pheasant and partridge.

There are several kinds of birds which might be styled half-wild, i.e., partly influenced by the habits or dwellings of human beings. In this category may be mentioned pigeons, sparrows, starlings, and in a certain degree rooks, plovers, peewits, water-hens. It is only the very

young rooks, viz., such as have just gained the power of flight from the nests, that are palatable ; and great care must be exercised in preparing them for the table to cut out the spinal column, for if the cord be in the rook-pie, the taste becomes as bitter as gall.

Thrushes, blackbirds, starlings, sparrows, woodcocks, quails, snipe, and herons are used for food. Woodcocks, quails, and snipe make very delicate and palatable dishes. Snipe suck up small water-snails and insects from puddles of water. They may be cooked in front of a fire, and as they have one long gut only, need not necessarily even be gutted.

"Herons are by no means so common as they were in days of yore. Although the first bird on the game list, and at one period a royal dish, it is quite the exception to meet people who have tasted them in these 'go-ahead' times." (John F. White, Grimsby.)

The heron's flesh has a slightly strong, but still pleasant taste—not unlike that of a hare which is not very young. It might not always be considered delicate food; but some egrets are said to be very delicious.

Jackdaws' flesh is too bitter for human food ; as also is that of many other wild birds.

The flesh of poultry and wildfowl, like that of game, is different from that of ruminating animals, in that the muscular fibres are not permeated by fat, and are also short, and hence more easily split up in the process of digestion. Those which have white flesh, such as the fowl, guinea-fowl, and turkey, and also the pheasant and partridge, are especially tender, delicate in flavour, and easily digestible : but the flesh of ducks and geese is dark, harder, stronger in flavour, and more difficult of digestion, partly owing to its large amount of fat. The pigeon has less flavour. Keeping for a time improves the flavour, especially, as above said, in grouse. Snipe, quail, and woodcock have a delicate flavour, but are too rich for invalids. Wildfowl, such as wild ducks and geese, have close and firm flesh of strong and often fishy flavour, not suited for invalids, though they may be palatable to some.

Mammalia.—Meat. The flesh of animals consists of muscle-fibres held together by connective tissue. When the fibres are coarse and long, as in the muscles of a crab's leg, they are less easily digestible than when the fibres are shorter and more delicate, as in the breast of a chicken. Meat contains 75 per cent water. The nitrogenous matter contains 1 per cent extractives and 2½ per cent albuminoids, such as collagen. The remainder of the nitrogenous matter is proteid.

The average annual consumption of meat, per head of inhabitants, is, for this country 136 lbs., for France 46 lbs., and for Germany 36 lbs.

In glancing at the different groups of animals, we may note certain points of interest and value.

Meat is really the edible flesh of any animal used as human food ; but is generally used to mean that of mammals living on the land.

Every animal's flesh has probably been eaten by man. Most of the meat used is that of cattle, sheep, and swine ; that of goats being eaten only to a small extent, though the author has often eaten it in South Africa, finding it much like mutton, but with a stronger taste and

odour. Horses and dogs are still less commonly consumed. The principal wild animals used are the deer, bear, hare, rabbit, and squirrel. The latter, as might be inferred from the nature of the food (nuts and fruit mainly), is very palatable, and so also is the insectivorous hedgehog.

For veal and lamb, the animal must be under two and not more than about from eight to twelve months.

Pig is the name given to the flesh of young swine, and pork to that of the grown animal.

The ungulata, or hoofed mammals, supply us with most of the flesh we consume. To this group belong sheep, goats, swine, oxen, deer, and horses. These are all herbivorous ; and, indeed, the flesh of carnivorous creatures, whether birds or mammals is, as a rule, not palatable. Buffalo flesh is also good in taste, and suitable for food.

The quality of meat is a very important point ; and it is well to beware of blown veal and lamb. To pioduce this condition, melted fat is taken into the mouth, and blown over the freshly dressed carcase. It is an offence against the by-laws of most places.

It may be said that mutton is more easily digestible than beef, though not so nutritious.

Rodents, such as hares and rabbits, are a favourite food of many ; but it is to be noted that the latter may often harbour a cystic form of tapeworm. The flesh contains less fat than that of poultry, and has a finer flavour. It is tender and easily digestible. The flesh of a young hare has short fibres, and is nearly as digestible as that of chicken, but more stimulating. There is probably no more delicious flesh than that of a leveret, unless, indeed, one prefers a grouse. That of a young rabbit is fairly digestible ; but that of older rabbits becomes dry, hard, and not easily assimilable.

The flesh of game contains less fat and more extractives than that of domesticated animals.

A point to be noted is that the mode of killing greatly influences the taste. If the blood be left in, e.g., a shot chicken or a suffocated duck, the flesh is deep-coloured, and the taste like that of game.

Horse Flesh.—Though both palatable and nutritious, the flesh of horses is used only very slightly in this country, and very many people have never partaken of it. Horse-tongue, finely minced, is very pleasant to the taste. In Germany its consumption is on the increase, as is shown by the facts that in Berlin in 1847 about 3000 horses were slaughtered for food ; whilst in 1902 there were 12,703 ; and, again, in the whole of Prussia in 1899 there were 63,801 ; whilst in 1902 the number was 85,820. Both in France and in Austria it is greatly used, and in Vienna in 1894, 18,209 horses were used for food. In France are public slaughter-houses, and care is taken that unhealthy horses are not used.

It seems peculiar that young rats—two-and-a-half months old—when fed exclusively on horse flesh, which is chiefly proteid matter with some fat, die very quickly. Of fourteen thus fed, six died on the

third day. Similarly, fourteen young rats fed entirely on porridge died within five months, the oatmeal being made into porridge by boiling with water and skim-milk ; while those fed on bread and milk got on well.

Horseflesh is eaten in large towns, especially on the continent of Europe, mainly on aeeount of its low price. In France, about 10,000 or more horses, asses, and mules are consumed annually. It eontains from ·5 to 4·5 per cent of glycogen and glucose, from whieh its sweet taste is derived. Asses' flesh resembles venison ; but mules' flesh has a musky taste.

Reindeer flesh is intermediate in taste between that of venison and that of beef.

Dogs' flesh is eaten in some countries, and at times of speeial stress and famine, e.g., the siege of Paris, and other sieges, when even rats and miee werc eonsumed, and in Nansen's Polar Expedition, and other like times of difficulty. When other meat ean be obtained, it is best to reject that of dogs. Certain kinds of these animals are fattened by the Chinese for human food. The Indians of the Upper Missouri also kept dogs for that purpose. The entrails and fat should in any ease be rejected, and the flesh be piekled in vinegar and spiees, and eooked for a long time.

Finally, we may mention the terrible eustom of the inhabitants of the Cannibal Islands, and other savages. Cannibalism is amongst some nations a religious or legal eeremony. Sometimes the right of eonsumption of dead bodies is eonfined to privileged groups, e.g., the Hamets of the American North West. Human saerifices with traees of cannibalism, shown by the eonsumption of the eyes or hearts of the victims by the chiefs or priests, are related to the original more eomplete cannibalism. Probably, man has always been a pantophagist, and this has gencrally been earried as far as eannibalism in all nations at their lower stages of dcvelopment. Endo-eannibalism is to be distinguished from anthropophagy, whieh is eonfined to eonsumption of the mcmbers of hostile tribes.

It was stated that during a famine in the interior of China human flesh was cxposed for sale in the market-plaee. It has also been reeorded that in some cases of shipwrecked erews, the members being well-nigh frantic with the pangs of hunger and their other terrible sufferings, have taken the same method of prolonging the lives of the survivors. Lots have becn cast to seleet the vietim. It is also well known that both rats and pigs will devour dead eomrades. Indeed, in the ease of swine, these animals will sometimes rcnd and devour a weakly eomrade, cven in some eases when fairly well fed themselves. The following is taken, with apologies, from *The Daily Chronicle* of Aug. 6, 1907 :—

Mr. McKean, in the House last week, characterized as " cannibals " certain natives of the Congo State. But the fact that there is a recipe for preparing human flesh in the English language will come as a surprise to the many. It figures in the ancient " Romaunt of Richard Cœur de Lion." In the course of a crusade the lion-hearted King, while recovering from an ague, longed for a dish of pork. Nothing porcine could be obtained on the arid plains of

Palestine, and the chef of the field culinary staff was in dire despair. Then an old knight tendered the suggestion :

> Take a Saracen young and fat.
> In haste let the thiefe be slayne,
> Opened, and his skynne off flayne,
> And sudded full hastilie
> With powdere and spicerie,
> And saffron of good colour.

An infidel was caught, killed, and dished up as advised. Richard greatly enjoyed the seasoned mess of " pork." Then he upset all calculations by mperiously calling for

> The head of that ilk swine
> That I of ate.

A clean breast had then to be made of the imposition. Richard graciously forgave everybody concerned. He made the comment that, as the Saracen proved such excellent eating, his army need never starve while unbelieving children of the Prophet could be bagged.

Men reduced to a nearly desperate state of mind have had recourse, as in times of siege, to eat the flesh not only of horses and donkeys, but even of cats, dogs, rats, and mice. Leaves of trees are freely devoured, as is said to have been the case in the siege of Pekin. Water also is drunk in large quantity to allay the craving for food.

Characteristics of Good Meat.—Flesh should be juicy but not wet, firm and elastic, and neither pit nor crackle on pressure. Good beef is spotted with fat and red, bull beef being dark ; but darkness in other cases may be probably due to imperfect bleeding. Veal is paler and not so firm. Mutton is dull red, firm, and its fat hard and usually white. Pork is pale, and its fat is soft.

The connective tissue of the flanks, shoulders, diaphragm, and kidneys of a carcase should be examined for wetness, œdema, imperfect setting, or diseased glands. Neither the chest nor the belly walls should have any signs of old adhesions or staining, or of any inflamed pleural or peritoneal membranes having been stripped off. The odour should be pleasant, and a skewer, thrust into the flesh, when withdrawn should impart no bad smell.

It is best to bleed cattle directly after they have been felled. The Jewish plan of cutting the throat is good, because the blood is thereby removed. The viscera should be at once withdrawn and examined.

The age can be inferred from the degree of ossification ; the cartilage being less as the years advance. Older animals have less fat, and their flesh is firmer. Stillborn, or newly-born calves, have flesh watery in appearance, and their fat is like tallow ; the hoofs are yellow, and so soft as to be indentable with the nail.

Unsound Meat.—The carcase is emaciated. The flesh is pale, and, perhaps, together with the connective tissue, shows the presence of serum. The fat and visceral connective tissue are wet and flabby, and the fat will not set. If an animal has not been killed until acute inflammation has occurred, the carcase is red and congested with blood, owing to imperfect bleeding. The flesh is dark, dry, and sticky, and will not set. A skewer thrust in may smell of drugs, or otherwise offensively.

Flesh from Animals that have Died or been Damaged or Killed by Accident.—The carcases of animals, drowned or smothered or naturally dead, are dark, because, the animals not having been bled, the blood is still in the body. The abdominal walls are stained, and signs of putrefaction are often seen. Such carcases should be destroyed. If an injured animal has been slaughtered and bled, only the damaged parts need be condemned, unless the results have extended to other portions, in which case it is usually wisest to destroy the whole carcase.

Tuberculosis.—Cattle, pigs, poultry, and rarely sheep, are liable to be affected. In early stages, i.e., when the disease is not far advanced, the flesh is fit for food. If, however, the malady has progressed, the muscles are soft, skinny, and dropsical, and the fat is wet and flabby. The Local Government Board advises seizure of the whole carcase, and of the organs, when :—

1. There is miliary tuberculosis of both lungs.
2. There are tubercular lesions on the pleura and peritoneum.
3. There are tubercular lesions in the muscles or in the lymphatic glands situated between, or in, the muscles.
4. Tubercular structures exist in any part of an emaciated carcase.

And advises all parts containing tubercles to be seized, when :—

1. The lesions are confined to the lungs and thoracic lymphatic glands.
2. The lesions are confined to the liver.
3. The lesions are confined to the pharyngeal lymphatic glands.
4. The lesions are confined to any combination of the above in cases where the lesions are collectively small in extent.

Further, in the case of the pig, on account of the great liability to rapid extension of the disease, the whole carcase should be seized. In regard to foreign dead meat, seizure is advised, when the pleura has been stripped. The question arises, if this should also be done when the head and neck have been cut off, because, thereby, implicated cervical glands are removed.

The question of the flesh of tubercular animals is so closely connected with the supply of milk obtained from animals thus diseased, that it seems well to state here that on both accounts seriously tubercular bovines or cows at any rate should be seized and destroyed, with compensation to owners. Many diseased animals, including tubercular milch-cows, are consumed as food. According to the Medical Officer of Health for Plymouth, writing in *The Nineteenth Century* for August, 1907, as is well known, if the inspectors are sufficiently vigilant, the sale of such diseased carcases may be prevented almost entirely ; but it is by no means easy to prevent the distribution of tubercular milk. The average number of deaths due to tuberculosis for the last five years in England and Wales was 60,000 ; of which 11,000 occurred in children under five years of age. Some of these may have been due to the ingestion of tubercular milk.

As to this question, the first Royal Commission reported that the ingestion of tubercular meat and milk produced tuberculosis in man.

Another Royal Commission reported in 1904 and 1907, that tuberculosis in bovines and humans is the same disease, and that the consumption of cows' milk containing the tubercle-bacilli causes a very considerable loss of life in the young. Cows kept in towns are healthier than those in the country, because the urban authorities are more strict in enforcing the sanitary regulations of the Cowsheds, Dairies and Milkshops Order of 1885. Hence, town-milk is less frequently contaminated. It is well to note that, even if there be thousands of bacilli in milk, the ordinary appearance is not much altered. Bacilli can only be detected with certainty by repeated tedious examination with highest powers of the microscope, or by the still longer process of injection of the milk into animals that are susceptible to the malady.

Cattle should be regularly inspected, and those found badly diseased should be compulsorily destroyed, and buried with antiseptic precautions, the owners being compensated for their loss in suitable cases. Rules for improving the conditions under which the animals are kept should be more strictly enforced. The officers appointed to carry out these measures should be under the control of a central, and not a local authority. If the work is to be carried out by the County Councils, a course which cannot be strongly advised, at any rate the medical inspectors should be managed by the Local Government Board, or this Board and the Board of Agriculture, either one or the other, or both conjointly, should take the matter in hand themselves directly, and so ensure, as far as possible, a cessation in the sale of diseased meat and milk.

We may say it is possible that the dangers arising from the consumption of milk and meat from tuberculous bovine animals have been exaggerated, and that it is even just possible that they may partially act as a safeguard against human tubercular disease, which, according to Koch, is distinct from the bovine malady, and incapable of arising therefrom.

For several years, and especially since Dr. Koch made his statement of the distinction between bovine and human tuberculosis, we have been of the opinion that the chances of getting the latter disease from tuberculous meat is for the greater part small. We extract the following notes from an article on "Consumptive Meat for Consumptives" in the *Daily Mail*, Nov. 29th, 1907 :—In the *New York Medical Journal*, Dr. F. W. Forbes-Ross, a well-known English specialist, proposes to actually feed tuberculous people on meat of tuberculous cattle. He suggests giving them the raw flesh of tuberculous bovines. In the blood of tubercular animals toxins are formed by the bacilli, which poison the system, and also antitoxins which counteract their injurious action by lessening the activity of the bacilli and their poisons. These antitoxins are present in tuberculous meat, and this, if eaten, adds these substances to those already being formed, wherewith to oppose the bacilli.

During the feeding of infants on milk, the possibility of tubercular infection is very high, and it is not unlikely that this springs from the fact that no immunity has had a chance to be produced by the

consumption of tubercular flesh. Secreting glands have not been shown to contain or produce any antitoxin, and hence milk is at once likely to contain many tubercle bacilli, and at the same time no antitoxins. (This, however, we ourselves believe, needs further testing, and may be found not quite true.)

By some of the old physicians raw minced beef was advised for young children suffering from so-called scrofulous conditions, especially of the intestines. These scrofulous disorders were no doubt tubercular, and the flesh would very likely be tuberculous, because the disease is very general in bovines, and in those days no precautions were taken to select meat free from that affection. Many doctors now advise raw meat for consumptives, who often refuse at first, and say they have avoided underdone meat. By thus acting they have probably lost opportunities of acquiring immunity.

The "opsonin" theory of Sir A. E. Wright claims that certain substances, which he calls opsonins, give immunity against certain bacillar diseases, and it seems probable that tuberculosis may be so prevented. At least the above article supports this hypothesis by citing the history of a family of six children. Five of these six children died of tuberculosis in childhood, while one, who was very thin and delicate in early youth, is now a healthy adult, and perfectly free from any tubercular taint.

This child lived and slept with her sisters even when they were dying, so there could be no question of a different environment. Her survival, then, must be laid to the account of some specially acquired immunity. It is suggested that the protection in this girl's case was due to the fact that, on account of her being a delicate child, she had been ordered by the family physician to eat raw-beef sandwiches. Taken first as a prescription, she grew to like them, and ate raw and underdone beef long after there was any apparent need for it. A certain percentage of the meat must have been from tuberculous animals, and to the antitoxins in this meat Dr. Forbes-Ross attributed her escape from the disease, while the other five children, none of whom were ordered the raw-meat diet, fell easy victims.

The vegetarian Negro and Asiatic, even in their own hot regions, are severely afflicted with tuberculosis, when once infected with it, and Dr. Ross suggests this great liability so to suffer is due to their never having acquired any degree of immunity from eating tuberculous meat. There are said to be several hundred thousand tuberculous cows in dairy herds in England, and some, being good milkers, are kept, so far as possible, from discovery by the sanitary inspectors.

The tuberculous animals might be collected on isolated farms, and slaughtered when wanted for food. They might be classified into various grades of disease, implying various grades of antitoxic activity, by being tested with Koch's tuberculin, and arranged according to the temperature resulting therefrom. It is held that the withdrawal of tuberculous milk-giving cows would remove a grave source of danger to the community, and especially to the infants (but we

think it is just possible perhaps that milk may also contain antitoxic substances).

Some would be fed on raw tuberculous meat freed from live bacilli by filtration. Dr. Ross also proposes to feed patients with measured quantities of active tubercle bacilli, relying on the natural or reinforced gastric juice to protect from new infection, and with the view of strengthening the immunity. In this case the meat would be finely minced, and added to a little cold normal salt solution, and then the juice pressed out. This would then be examined with a microscope to see how many bacilli were present, and the solution of the juice further diluted with salt solution, so as to give the number of bacilli thought to be right.

"Probably it will be a long time before such revolutionary suggestions as those comprised in this treatment will be taken seriously by conservative students of England's greatest enemy—tuberculosis; but the method is being tried in Germany on rather a large scale, and statistics showing results of scientific treatment along these lines will be eagerly awaited by every broad-minded man who realizes how helpless we are at present before the attacks of the Great White Death."

Pleuro-pneumonia, especially if in an advanced stage, renders the flesh of animals affected with it unfit for food.

Anthrax and *anthracoid diseases* may attack cattle, sheep, pigs, and even men, the glands, liver, and spleen being affected. The flesh has a peculiar odour, and readily decomposes. The carcases must be destroyed, and buried with quicklime, as was always enjoined by the authors' father.

Foot-and-mouth disease affects cattle, sheep, swine, and even human beings. There is ulceration of the tongue and mucous membrane of the mouth. Blisters occur on the hoofs. The flesh may possibly be fit for food in mild cases.

Swine Fever, also called purples, swine typhoid, soldier, etc., renders the flesh unfit for food. There are red patches on the skin, extending through the subcutaneous fat to the flesh, which becomes pale, soft, dropsical, and malodorous. The intestines, especially the large ones, have coarse ulcerous lesions, like those of human typhoid fever.

Preservation of Food.

All moist animal and vegetable substances are liable to putrefy, if warmth, oxygen, water, and certain bacteria, e.g., *Bacillus subtilis*, which is always present in air, are at hand. There are some eight modes of preservation.

1. *Exclusion of Air.*—Aerial germs are cut off. In the case of meat, it is dipped into boiling water, so as to form an impervious layer of coagulated albumin, or coated with paraffin or melted fat. Similarly, wines and beers are bottled, and the bottles closed by cotton-wool; or the wine may be covered with a film of oil. Eggs are covered with gum. Preserved fruits, green peas, and other vegetables, unsweetened condensed milk, American canned meats are put into

bottles or other receptacles containing boiling water, immersed in the same, and corked or sealed whilst boiling.

2. *Drying by Removing Water.*—Thin layers of meat are placed in dry air, in the sun, or in the smoke of a wood fire. Sun-dried beef is the staple food of the Indians of the Pampas, and biltong is similarly prepared by the Boers. Potatoes are also sliced and dried, and other vegetables and fruits, raisins, currants, figs, apples, and pears are also dried.

3. *Addition of Germicidal Reagents.*—Fish are boiled and kept in oil. Fruits and vegetables are preserved in spirits, vinegar, and sugar. Sweetened condensed milk, jams, and preserves owe their preservation to excess of sugar. Smoked hams and salmon are partly dried, and partly impregnated with the tarry products of combustion of peat or coal, or of dry distillation of wood. Salt abstracts water, as well as impregnating the tissues. The meat is soaked in brine, i.e., strong solution of salt. The soluble albumins pass into the brine, as also do the potash salts of the meat. Hence the meat is not only made indigestible, but also less nutritious. However, the salt can be removed by placing the brine in a dialyser over water. The meat should first be steeped in cold water to get rid of the salt, and then boiled in the brine thus dialysed. Saltpetre is added to the salt, a mixture of salt and saltpetre being rubbed into the meat. Other preservatives proposed are sulphurous acid, sulphites, boric and salicylic acids, formalin. Essential oils and spices have also some little antiseptic power.

Another way is to inject the blood-vessels with water, and then with a solution of alum and chloride of aluminium or of sodium. Another is to cover with salt, sugar, boric acid or boroglyceride, powdered charcoal, weak carbolic acid (which last is poisonous), or it is kept in a closed vessel containing volatile oils or other antiseptics.

4. *Extremes of Heat and Cold.*—Heat kills germs, and is therefore applied before sealing, as said above. Soups can be kept by being boiled daily, or may be hermetically sealed in tins in vacuo or sterilized air. If the tins are blown, the contents are bad. There may be a little of salts of Sn, Zn, or Pb in the meat or jelly, the salt or organic acids having acted on the tin or solder. Cooking coagulates the myosin and other albumins, and softens the meat by turning the connective tissue into gelatin. When boiling meat, first boil for five minutes in boiling water, and then continue at a lower temperature. Also for roasting, first expose to an intense heat, and continue at a lower degree. Ordinary cooking does not sufficiently destroy a specific virus.

If meat be frozen before *rigor mortis*, it is safe to keep; but if *rigor mortis* has set in first, the flesh decomposes when thawed. The cold prevents putrefaction. In country houses in Russia, Sweden, and Canada, it is usual to lay in a stock of meat for the winter, and keep it frozen. Ice will cause an arrest of decomposition, and absence of odour; but both reappear on cooking, if they have set in before the freezing. It is not always essential to actually freeze the meat, as, if subjected

to a temperature slightly above freezing-point, it keeps fairly well. In that case it is called refrigerated or chilled meat, which is now imported into Great Britain in large quantities. As a rule it keeps well, and is a very useful addition to the meat supply. Indeed, many persons cannot afford any other kind, and several select it not merely for economy, but also from choice, liking the flavour, which is often not quite so sweet and delicate as English meat. Some object to it on that very score, and also because they think the muscle fibres are larger and perhaps sometimes a trifle coarser, and hence less easily digestible. At any rate, it is doubtless just as nutritious and safe—perhaps often even more so.

Quarters of beef and whole carcases of sheep are wrapped in muslin. The surface is sometimes wet, owing to thawing. Frozen rabbits are sent from Australia and New Zealand, and frozen poultry chiefly from Canada.

Sometimes the meat is tinned, and such canned meat from Australia and Canada is often very good. The latter colony not being very far distant, sometimes the meat, as said above, is chilled, and not actually frozen. In the case of Australia and Canada the regulations are very well carried out, so that no bad meat can be exported. Though alarmist rumours cannot be fully credited, still one cannot always feel equally confident respecting the good quality of canned and other meats coming from some other countries. Indeed, tinned goods should be very carefully scrutinized; but it is possible that there has been exaggeration in the alarmist revelations and allegations in regard to American canning factories. Many of these at any rate are well conducted, and like the bulk of the Australian and Canadian houses above suspicion of flagrant faults. Even in those of less merit, great alterations in the way of improvement have been, are being, or will doubtless soon be, made.

It has been maintained that appendicitis may have been caused by the consumption of frozen or chilled meat or other provisions; but this is probably an entirely erroneous suggestion, for in the first place it is not even proved that the affection is so much more prevalent than in former times as is generally supposed, and even if that were admitted, there is no proved connection betwixt the complaint and the ingestion of such food. It is probably at any rate not at all more prevalent amongst those who consume such food than amongst those who live mainly on fresh meat; and further, the writer is of opinion that, though the disease is certainly more often recognized and diagnosed, it is not much more prevalent now than formerly. The conditions which would now be at once so designated used to be otherwise denominated. A similar explanation also in part simplifies the apparent difficulty of the widespread vogue of influenza in recent years. As science becomes more exact, it also gains in simplicity, and hence also in intelligibility. Previously unsuspected resemblances and chains of causation become clear. The widespread occurrence of certain derangements in recent times, such as for example influenza, cancer,

appendicitis, floating kidney, though at first sight apparently extraordinary, is explicable quite easily as, to a large extent, resulting from fuller knowledge of those disorders. Especially is this true of so protean a complaint as influenza, and no doubt it is true that the surgeons of older times opened abscesses resulting from appendicitis before either this name of that disorder, or the use of antiseptics or anæsthetics, were known. Possibly, indeed, though called by other names, it was nearly as often met with, comparatively speaking, as it is now. We say, nearly as often, but not quite, for one of its probable causes, the decay of teeth, is probably more frequent now than in more primitive times. Imperfect teeth give rise to insufficient mastication, and this favours chronic constipation. This latter condition, whether thus caused or springing from other factors, is doubtless a fruitful source of appendicitis, as before mentioned.

Good colonial and foreign meat, properly prepared, preserved, and chilled or frozen, is quite safe, as repeated experience proves. The fact of meat having been frozen does not appreciably impair its value, and far less does it cause any dangerous change. Of course the greatest care is necessary in the selection, preservation, and preparation of all food for the table. It would, however, be a pity if unfounded prejudice should result in relegating colonial meat and produce to a bad position for sale, because it is just as safe as, and sometimes more safe than, even English meat.

Refrigerated Canadian meat is inspected in that Colony, and also in England, and stamped; and Australian, New Zealand, and American meat is likewise doubly inspected before it can reach the British consumer. As a rule, too, the oxen and sheep whose flesh is frozen have grazed on very fine pastures. There are men who have eaten such frozen meat for a quarter of a century, and the writer can personally by long experience testify to its good and nutritious nature, though of course one cannot expect either that it should be always good, a merit which no kind of meat possesses, nor that it should be as superior in quality as the best fresh and healthy British-fed meat, carefully butchered, and properly prepared. However, one may possibly meet with diseased meat from any country. Improvement in regard to meat-inspection has been already secured, and it will go further. Meat inspectors should be watchful and vigilant, especially in regard to anthrax and tuberculosis, both in Great Britain and elsewhere. It is said that sometimes tubercular swine carcases are sent here, with their heads and necks removed, so that the enlarged cervical glands cannot tell their tale. Indeed, all kinds of food are apt to be dangerous, especially in hot weather. As was said above, one point to the advantage of frozen meat is that the bodily heat is removed, whereas in the case of our own meat this is not so. Hence the latter will, in warm weather, decompose quickly, and we have heard from one concerned with Canadian meat that he has never seen it turn green like British meat, though it may, under very unfavourable conditions, soften.

It is also well to bear in mind that English meat is not always above suspicion, and there have been rumours of trusts controlling even our home markets, as well as foreign ones, to the disadvantage of the honest purveyor of exclusively wholesome meat. A thorough system of supervision of slaughter-houses in all countries is really an indispensable condition for the safety of the public; but after all, each person must also be self-protective in the matter of food. It is not always the dearest provisions that are the best, but one should not be guided only by mere cheapness. There is, however, no doubt that thousands have eaten and do eat scarcely any meat that is not foreign for years, and certainly do not suffer in health or vigour by so doing.

Cooking diminishes the digestibility of animal foods, but increases that of vegetables. Meat is very completely absorbed in normal and healthy digestion, only about 5 per cent of its dry matter being left.

Raw meat may be prepared by scraping the fibres away from the connective tissue with the back of a knife. The pulp may then be spread on bread in sandwich form, or stirred up with a small quantity of beef tea, a little celery-salt being added. Jelly is very beneficial for febrile patients.

Finally, we may here repeat that the ingestion of shell-fish like oysters and cockles may disseminate typhoid and other fevers, and again allude to the danger of eating high game. One should be careful, too, in regard to rabbits, on account of parasites which are liable to infest them, and also as to imperfectly cured fish.

Milk.

Average Composition of Milk per 100 Parts. (R. H. Firth.)

Kind.	Sp. Gr.	Total Solids.	Proteins.	Fats.	Carbo-Hydrates.	Salts.	Water.	Prop. of Nitrogenous to Non-nitrogenous Constituents.
Human	1027	12·60	2·29	3·81	6·20	0·30	87·40	as 1 is to 4·4
Cow's ..	1032	12·83	3·55	3·69	4·88	0·71	87·17	,, 1 ,, 2·5
Mare's ..	1035	9·21	2·00	1·20	5·65	0·36	90·79	,, 1 ,, 3·4
Ass's ..	1026	10·40	2·25	1·65	6·00	0·50	89·60	,, 1 ,, 3·4
Goat's ..	1032	14·30	4·30	4·78	4·46	0·75	85·71	,, 1 ,, 2·0
Buffalo's	1032	18·60	6·11	7·45	4·17	0·87	81·40	,, 1 ,, 1·9

Milk is natural food provided for the mammalian young, and it contains all the elements requisite for nutrition in the proportion most suitable for the infant's needs. Even for adults, if supplemented by carbohydrates from other sources, it is also valuable.

The average composition of cow's milk is approximately:—

Water		87·17 per cent.
Fat		3·69 ,, ,,
Solids, other than fat, viz.—		
Proteids	3·55	
Carbohydrates ..	4·88	
Inorganic salts ..	·71	
	——	9·14 ,, ,,

The specific gravity varies from about 1027 to 1034—perhaps usually 1032 or thereabouts.

The proteids are caseinogen and lactalbumin, there being seven times as much of the latter as of the former. The chief mineral present is lime, one litre of milk containing $1\frac{1}{2}$ gram of it. There are in 5 pints only the 10 milligrams of iron required daily by an adult.

Human milk contains less proteid, but more sugar and fat, than cow's milk. Taking the city of Liverpool as an example of the amount of milk consumed, about 24,000 gallons are supplied daily, this being an average of one-third of a pint per head. A little more than half comes from cows kept within the city. Cows, especially those used for dairy purposes, should be healthy, and live in sanitary quarters. Each cow should have 700 cubic feet of space, and byres should be well lighted and ventilated, and kept thoroughly clean.

Milk may contain pathogenic organisms coming from the cow or from outside sources. There may be tuberculosis, and this may infect any organs, e.g., most noticeably the lungs or udder, or both. About 17 per cent of the milch cows of this country are affected, about 2 per cent have tubercular udders, and about 9 per cent of the milk is implicated. This probably occasionally produces some form of disease in man and animals consuming it. Hence milch-cows should be examined at intervals to see if they are healthy; but as a rule it is only in sheds that are badly constructed or kept, that the malady is frequent.

If there be tubercular affection of the udder, as there may be even in slight attacks of the disease, the risk is greater, and a tubercular animal may give tubercular milk, even though the udder be not palpably diseased. If a cow be certified to be affected, the milk must not be supplied for human beings, and only even for swine after being boiled. For detection of the tubercle bacillus in milk, guinea-pigs are inoculated subcutaneously or in the peritoneum, as the microscopic test is not a satisfactory method. Strange to say, tubercle bacilli are found more than twice as often in milk taken from the country than in that from the towns, and this is doubtless due to greater lack of sanitation in the country than in the town.

Again, tubercular milkmen may impart the human tubercle bacillus. For this reason also, as above said, the milk should be boiled, whereby such dangers are obviated. The germs of milk can for the most part be destroyed, by boiling the fluid for a few seconds, or raising it to a temperature just below boiling-point. Pasteurisation, i.e., exposure to 70° C. for twenty minutes, kills most pathogenic germs, but does not devitalize all spores, nor the bacteria which produce lactic acid, and for this last reason it is preferable, because these bacteria are beneficent. This process consists in placing the milk in stoppered bottles, and setting these vessels containing the milk in a deep saucepan of water heated to 70° for the time just stated. Or, as above said, it may be heated to boiling point. The digestibility of milk is hindered by the dense clot which it forms in the stomach. The degree of the density depends on the amount of casein, of acid and lime salts in the stomach. Water, barley-water or lime-water will lessen the density

of the clot. If one fluid part of lime-water be added to each two fluid parts of milk, the clot will be loose. If a man doing a moderate amount of work were fed exclusively on milk, he would require about nine pints ; and about half this amount suffices for a sick person lying in bed.

Thus, as it has been indisputably proved that diseases may be disseminated by this very valuable fluid, milk, one cannot be too careful in regard to its purity and cleanly preservation. The skilful research of the ablest pathologists has made the public authorities keenly alive to the importance of the subject, and it is generally known that milk should always be boiled or heated, as above said, before use. It is as important as the cooking of other animal food, which is admittedly dangerous unless well baked, boiled, or roasted. Milk is just as liable as flesh to the presence of germs. There are also other dangers, e.g., sometimes it is watered, deprived of its fats, or adulterated with injurious amounts of preservative drugs, such as formalin or salicylic or boric acids. The presence of added water in milk is a little more frequently found in samples taken on Sundays, perhaps because the milkmen are apt to be a little more slack on the day of rest. Watered milk, at least if the water be impure or contain germs, and also that obtained from stall-fed cows, and also that to which any preservative has been added in dangerous amount, are, one and all, unwholesome. Again, epidemics of enteric and scarlet fevers and of diphtheria have, as above said, been traced to milk. For example, a milkman admitted in one case that his milk-cans had been washed out with water from a well proved to have been infected by sewage from an adjacent cess-pit which contained typhoid excreta.

The typhoid bacilli may be introduced by sewage, water, or dust, as also may the diphtheria bacilli, which in four cases have been isolated from milk which was suspected of conveying the malady. However, some believe that diphtheria is a disease of the cow, and that the bacilli pass from the udder into the milk. The same possibility has been alleged, and partly substantiated, by Drs. Power and Klein in regard to scarlet fever.

As above indicated, milk is one of the most valuable articles of food, containing nearly all the materials of which blood is composed, and yet it is very liable to communicate diseases, though this risk can be obviated, or very materially lessened, by boiling or heating highly before using as food. Vendors of this fluid cannot be too careful in regard to cleanliness. Some people in country places even find it wise to keep their own cow or cows, when convenient to do so. The public should of course protect themselves against obviously faulty milk-purveyors, yet, even when the public officials as well as the purchasers have taken all possible precautions to secure a pure supply, it is still perhaps best to have the milk heated or boiled. Objections to these courses are the trouble, the fact that the ferments are destroyed by boiling, and also the bacteria which cause the formation of lactic acid, these being supposed salutary by Prof. Elie Metchnikoff,

as causing the destruction of more deleterious bacteria. Hence healthy sour milk is good, and heating preferable to boiling.

> "Gie a bairn his parritch,
> And dinna' spare the sour douk-can,
> And with a penny carritch
> I'll mak' your son a man."—(*Scotch Adage.*)

Milk from healthy animals is naturally free from disease; but, in the act of being withdrawn, and during transit, becomes loaded with bacteria to a greater or less extent. If there be disease of the udder, or of the animal generally, a further source of germs is added; and hence this fluid often contains millions of them in each cubic centimetre. These are (1) Ordinary bacteria of soil and water; (2) Those of sewage, manure, both of intestinal and other origin; (3) Those of fermentation; (4) Those of tuberculosis, enteric and scarlet fevers, diphtheria, sore throat, and epidemic diarrhœa; (5) Various kinds of streptococci. Considering the bacteria of fermentation, there are five different kinds affecting milk, viz.:—

1. Lactic acid.
2. Butyric acid.
3. Coagulation without acid.
4. Alcoholic fermentation.
5. Various other kinds of changes.

The first, lactic acid generation, is what occurs in the ordinary souring of milk. The casein is precipitated, the serum rises, carrying up lumps of fat, and the reaction is acid. A group of bacilli, the *Bacilli acidi lactici*, produce these changes, having gained access from the outside. Particular kinds are found near particular dairies, soils, localities, and hence the milk and butter coming therefrom possess different flavours according to the locality. These bacteria are short rods, most of which do not give rise to spores, nor liquefy gelatin. Some, however, do liquefy gelatin, and some produce spores, and some produce gas. However, they grow readily on gelatin at the ordinary temperature of rooms, forming small circular colonies of white or grey or yellowish colour, and with a smooth and glistening surface. If the acid rises much above 2 per cent, the bacteria do not go on growing. In addition, acetic and formic acids, alcohol, methane, CO_2, and other compounds are formed. Some lactic germs grow well in the presence of oxygen, and others do not. Most frequently met with are the facultative anaerobes which cause souring best in deep vessels, and a right-handed lactic acid. They are present in most localities, and may comprise as many as 90 per cent of the total bacteria of milk.

Butyric acid fermentation is caused by the *B. butyricus*. Hydrogen and carbonic acid gases are produced. It is not so important as lactic or as alcoholic fermentation by yeasts, whereby koumiss is made from mares' milk, and kephir from that of goats, sheep and cows, in each case by a combined lactic and vinous fermentation. In both koumiss and kephir the caseinogen is thrown down in a finely flocculent,

easily digestible form, and is also partly peptonized. Most of the sugar is converted into lactic acid, and there is a little alcohol and much CO_2. Such microbes as the lactic acid bacillus contained in sour milk disinfect the intestine.

The most common and fatal maladies of children are intestinal diseases of bacterial origin; but fortunately, in the old these are comparatively speaking rarely met with, though cancer of the intestine is the most common cause of death in aged people. As an example of the mortality of infantile diarrhœa, we give the following, taken from *The Times*. The average London annual death-rate during the five years ending 1905 was 16·5 per 1000. In the early part of the summer of 1906 it was well below that; but during August it rose steadily until in the first week of September it was 20·9 in London, in Croydon 30·7, in Coventry 32·8, and in Grimsby 33·8. The deaths in London from diarrhœa were 529, of which 502 were those of children under 5 years of age, and the former number was 288 above the average. Nearly one-third of all the deaths were due to diarrhœal diseases, mostly in children under 5 years old, and 80 per cent of these were under 1 year old. Every summer thousands of children thus die. Infantile mortality is terrible. All babies under six months should live on pure milk. Diarrhœa occurs especially during the third quarter of the year, being particularly prevalent when the temperature is high, and the rain slight or absent. Most of the victims are hand-fed babies, fed on milk or other foods which contain bacteria accompanying filth. Indeed the germs are communicated to the food by particles of dust or dirt, air-borne, hand-borne, or carried on the legs and wings of house-flies, or perhaps mice. Sunlight is a powerful purifying agent; but in London it is kept off to some extent by the 300 tons of soot daily cast into the air from the chimneys. Dirt of the streets should be washed away by watering them, and house-refuse should be more frequently removed from all pits or receptacles than is generally done. Hundreds of tons of horse-manure are daily cast upon the London streets, and in hot weather much of this is converted into a fine dust full of bacteria. This should in every city be specially removed, and as speedily as possible. All these causes contribute to increase the death-rate, and produce illness—even perhaps tetanus occasionally. Yet the main fact to bear in mind is that, as milk often gets dirty owing to the above and other causes, hand-fed babies are far more likely to die of diarrhœa than breast-fed ones.

The mortality of infants below 3 months of age is 15 times as great in the case of those fed on cows' milk together with artificial food and breast-milk, as in those fed on breast-milk alone, and 22 times as great as in those fed on cows' milk and artificial foods exclusively. That is, for each baby fed on mother's milk dying before 3 months, 15 otherwise fed babies die. Hence breast-milk should, so far as possible, be the sole food of the earlier months. No bread, sops, gravy, nor any food save milk should be given until the baby be 7 months old. The heavy mortality is probably largely caused by irritant organisms,

present in milk which is not fresh, during the summer and autumn. Such milk, inoculated into guinea-pigs subcutaneously or peritoneally, kills them in forty-eight hours. Terrible is the destruction of infants by putrefying artificial milk-foods, in which those irritant organisms giving rise to fatal gastro-enteritis are present. It is necessary that, if breast-milk cannot be given, pure and clean milk and water should be. Babies should be fed every two hours during the day, and about every four hours at night.

Butter is composed of the fatty parts of the milk made to adhere by agitation. It has about 80 per cent of fat, and a small amount of proteid, the rest being water. Margarine made from the more oily components of animal fat has almost the same composition.

Cheese consists of the casein coagulated by rennet, with or without the fat of the milk, modified by the growth of various micro-organisms which impart the flavour by means of bye-products. It is rich in both proteid and fat.

Eggs are similar in composition to milk, but contain much less water. The white part consists of various proteids, chiefly egg-albumen. The yolk consists of greatly emulsified fat and much lecithin, other organic compounds of phosphorus including a nucleo-proteid, and an organic compound of iron. One egg is equal in nutritive value to a quarter of a pint of good milk, and 20 eggs would be requisite for one day's food. Eggs contain 74 per cent of water, 14 of nitrogenous solids, 11 of fats, and 1 of salts. The hen's egg weighs about 2 oz., of which 60 per cent is white, 30 per cent yolk, and 10 per cent shell.

Eggs may be kept from entry of air by coating the shell with butter, lard, oil, wax, gum, varnish, silicon, or by boiling for thirty seconds, to solidify the superficial layer of albumen. They may also be preserved by immersing in lime-water, salt water, or solution of boro-glyceride. However, new-laid eggs are preferable, because the albumen becomes less easily digestible, in proportion to the time they are kept.

In order to detect staleness or putridity, it is a good plan to place the eggs in a solution of two ounces of salt in a pint of water, in which good ones will sink to the bottom, and stale ones float ; also it is to be noted that fresh eggs are transparent in the centre, and stale ones at the top. A lightly boiled or poached egg is not difficult of digestion, though a hard-boiled one is. However, raw eggs are not more digestible than lightly cooked ones, and they may introduce germs and the ova of parasites.

The white part of eggs may contain microbes and even entozoa, and hence whipped cream, being made of insufficiently boiled white of egg, may be a source of danger in those respects (Metchnikoff).

Vegetable Foods.

Not only do we obtain from plants means of shelter, ornament, clothing, and fire, but also to a large degree our food as well. Some fruits are most luscious. Trees, e.g., the palm, both the sago and the cocoanut palm, supply the Malays, Papuans, and Polynesians with food

all the year round. The forests of Brazil contain very many fruit-bearing trees which furnish both food and drink. The bread-fruit tree, with its fruit as large as melons, supplies the Polynesians and the inhabitants of the Malaccas with food. The dûm-palm and the date tree supply food to African tribes. The great utility of trees caused arboriculture to be developed, and agriculture also began by the collection of seeds of wild plants, berries, and edible roots, this being at first carried out mainly by the women.

Vegetable foods contain much more carbohydrates and much less proteid than animal foods. The chief carbohydrate is starch, though fruits contain sugar instead. On account of the small amount of proteid in vegetable foods, it is necessary to eat much of them to supply a sufficiency of nitrogen. If too little proteid be taken, the energy and power of resistance to disease seem to be diminished. Vegetables contain certain acid salts and acids which are excreted as carbonates in the urine, and are useful for patients afflicted with gravel and gout. They contain much cellulose, and therefore are not easily digested; of them cauliflower is most digestible. They have but little carbohydrate, and therefore may be used in severe diabetes.

Fruits may be divided into flavour-fruits and food-fruits. Flavour-fruits are berries which are useful on account of the vegetable salts of potash contained. Food-fruits are the banana, fig, date, etc., which contain a large amount of carbohydrate in the form of sugar. These are used in Egypt in the place of cereals. The chief sugar of fruits is lævulose, which suits diabetes better than any other carbohydrate. Nuts are rich in cellulose and fat, and contain little carbohydrate, being therefore suitable for diabetics.

Fungi, Lichens, and Algæ.—Fungi include mushrooms and truffles, which are indigestible and very incompletely absorbed. The algæ, represented by Irish moss, and the lichens, by Iceland moss, make palatable demulcent drinks.

Cereals.—Wheat is mainly used in England, wheat and oats in Scotland, maize in America, and rice in the East. Maize is superior to wheat in respect of fat, but rice has only a small amount of proteid and fat. Oats equal maize in respect of fat, and are superior to wheat in proteid, being the most nutrient of all.

Semolina is a preparation of the central parts of hard wheat, and contains 10·6 per cent of proteid.

Vermicelli and macaroni are made by mixing good wheat flour into dough, and then drying.

Hominy is split maize, but has only one-half per cent of fat. Corn-flour is mainly starch made from maize.

Pulses.—These are richer in nitrogen than other vegetable foods, containing a proteid called legumin (vegetable casein). They should be cooked in soft water, because this legumin forms insoluble compounds with lime.

So, beans and pea-nuts, which contain only a small amount of carbohydrates, are much used for preparing diabetic foods. Sometimes

more sulphate of copper than is wise is added to tinned or bottled peas, beans, etc., in order to make them look green and fresh when pale and withered.

Roots and Tubers.—These contain largely starch. However, potatoes contain much less starch than bread, and are hence more suitable for diabetics.

Tapioca, sago, and arrowroot have about 88 per cent of starch, and practically no nitrogen, and are hence mainly useful as adjuncts to milk. Being almost totally absorbed, they are beneficial for diarrhœa.

Food Accessories.—These stimulate the digestive secretions, and also the muscular movements of the alimentary organs. They include the simplest aromatic principles, which can be smelt when meat is being cooked, also condiments and spices, and beverages. Condiments include mustard, pepper, onions, cloves, nutmeg, cinnamon, all of which contain aromatic oils, and should only be taken in moderate amount. Beverages are (1) Liquids containing alcohol, e.g., beer, wines, i.e., light and sweet wines, and spirits. Beer and wines* contain ethylic alcohol, ethers, aromatic substances, and other principles; (2) Liquids containing caffeine or theobromine, e.g., tea, coffee, Paraguay tea, cocoa; (3) Liquids containing organic acids and other salts, e.g., lime or lemon juice and vinegar.

Mineral or Inorganic Constituents of Food.

About 5 per cent of the weight of the body is taken up by ash or mineral matters, which are essential to life as tissue-builders. If food entirely devoid of inorganic material were taken, life would only last for a few weeks. Some sodium, potassium, calcium, magnesium, iron, phosphorus, chlorine, and traces of manganese and silicon are required. An ordinary mixed diet contains about 20 grains of mineral matter. Scurvy seems to be due to want of mineral, and is cured by taking lemon or lime-juice.

Rice contains the least amount of protein and the greatest quantity of starch of all the cereals, whilst oats have the largest quantity of protein and the smallest of starch. Hence if it be true that man can be nourished almost exclusively on rice, it would seem *a fortiori* possible to maintain life satisfactorily on a more generous vegetable diet. Yet we find as a matter of fact that human beings fed on too large a proportion of rice are liable to suffer from beri-beri, and the Japanese have in consequence replaced much of the rice in their dietaries by bread, the disease being by this change diminished. It may be that it is rather due to a want of some element in the food than to any actual wrong constituent in the rice. However, the causation of the malady does not appear to be really known.

Vegetables contain more potassium, and animal foods more sodium. Potassium is an essential constituent of every living cell. Salts of sodium are most abundant in the fluids of the body, and especially

* Tokay wine is palatable, and also valuable in containing phosphorus.

in the plasma of the blood. Herbivorous animals greatly like sodium chloride, whilst carnivorous creatures show distaste for salty articles of food. Vegetable products are rich in salts of potassium, whilst ordinary animal foods, e.g., meat, eggs, milk, and blood contain rather little potassium. The taking in of salts of potassium causes withdrawal of sodium chloride. Hence animals which live on vegetables have a liking for, because of the loss of, salt. However, when ordinary cereal legumes or potatoes constitute the chief food, only a few grains of salt daily are required.

Barley is sometimes adulterated with mica, which can be removed by washing with water.

Cayenne pepper has been found dangerously adulterated with red lead; and vinegar is often manufactured from oil of vitriol, diluted freely with water, to which is added a little cider or wine vinegar to give it the proper odour and flavour. The presence of sulphuric acid may be detected by the formation of a white precipitate, sulphate of barium, when a few drops of solution of chloride of barium are added.

Cooking fruit in brass or copper kettles is still sometimes practised; as also is the making of pickles in such metallic vessels, for the purpose of giving them a fine green colour. All copper vessels should be kept clean and dry, and then may be safely used for cooking.

Black tea is sometimes coloured with "black lead," which, however, is really graphite or plumbago, contains no lead, and is quite harmless.

Green tea owes its bloom to a mixture of prussian blue, indigo, and china clay, which is liable to produce indigestion.

Salt and sugar are needed by nations which consume much vegetable food. Primitive man found that the eating of honey and licking of salt helped to preserve the muscular power. The need of these two articles have largely promoted commerce betwixt the peoples of the world. White sugar is sometimes adulterated with ultramarine.

Calcium is contained especially in milk, eggs, cereals, and a few vegetables, e.g., radishes, asparagus, and spinach; whilst only a little of it is present in flesh, fruits, and potatoes. About 10 mgrams of iron are contained in an ordinary daily diet. Yolk of egg, potatoes, bread, oatmeal, and rice contain most iron. Milk contains 10 mgrams in 5 pints.

Phosphorus helps to form new tissues, and the richest sources of organic phosphorus are yolks of eggs, and tissues rich in nuclein, e.g., roe of fish, sweetbreads. Inorganic phosphates are of little value.

Sulphur is ingested in proteids, and chlorine in the form of common salt. It aids digestion, and, if sufficient water is drunk, salt probably limits tissue-waste, and serves as a useful disinfectant in the blood, especially, perhaps, if much meat be consumed.

In regard to accidental, or rather unwitting, introduction of poisons into the system, it may also be incidentally pointed out that flour is sometimes adulterated with *alum*, which may be detected by the deep purple colour produced by soaking bread made of it in a weak solution of extract of logwood; and also that some hair-dyes and face-powders are not free from poisonous ingredients. Such should be avoided.

Chapter IX.

NATURE-CURES, VEGETARIAN DIET, AND FASTING.

Although coming under several headings, as well as that of Food, some remarks may here be incidentally made respecting the ideas now so much to the front, which may be included in the phrase, "Nature-Cure." The belief seems to be that, as during civilization we have digressed from the habits of primitive man, a return to them in some degree for a time is likely to evoke the latent powers of the constitution. No doubt there is much to be said for an occasional recourse to a less luxurious style of life. In the "Nature-Cure" establishments one sleeps in a châlet in an enclosure which is fenced round with a seven-foot-high wood partition. There is one enclosure for men, and one for women. The buildings are on high ground for preference, and the soil should be sandy or gravelly if possible, though neither of these conditions are indispensable. The patient usually has, the last thing at night, a hot foot-bath, the water being gradually made hotter, and then finishes up with sitting in it (sitz-bath). That is done before getting into bed at about 9.30 p.m., and also a glass of warm water is drunk. If the weather is suitable, all windows, and perhaps also the door, are left open. Some of the establishments are closed in the colder months, viz., from the end of August or September to about the beginning of May. The sheets are made of Aertex cellular linen, and, if possible, the sleeper is advised to sleep with nothing on. If inclined to be sleepless, before the foot-bath the patient may, unclothed, walk or run round the enclosure; but this can, of course, only be safely done to any extent by those who have become gradually accustomed to the practice. In the morning, about 7 or 7.30 a.m., an attendant brings a glass of hot water to be drunk whilst one is still in bed. After a few moments the patient rises with nothing on, goes out on to the grass, and walks or runs round the enclosure. If feeling chilly, one rubs the body with the hands. The next thing is the morning bath, which is taken in cold water in an oblong concrete structure, only about six inches deep, three feet wide, and six feet long. An inlet-pipe, when its tap is turned, supplies water, and an outlet-pipe removes it, when the plug is withdrawn. The feet are placed outside, after being first dipped in the water, and one sits in the bath, and, for about four minutes or so, laves the front of the abdomen with the cold water. Then the attendant gently rubs down the back with his bare hands, and next one takes a turn or two round the enclosure, and then goes into one's châlet, and dresses. The next item is breakfast, which begins with fruit, and includes porridge, an egg or eggs, milk, butter; but is,

with the exception of the last three, vegetarian. Walnut-butter may be provided. The rest of the day is spent according to special instructions, or one's own inclination, for there is no compulsion—every one, so far as possible, doing what seems best in his or her own eyes. However, one is advised to do without tea, salt, or tobacco.

All meat and alcohol of any kind, as well as salt in some establishments, are forbidden. It is said that, though salt may agree with animal food, and help to diminish its deleterious effects, it is not required with a vegetarian diet. Yet this is contrary to the opinion of scientists. For example, according to Bunge, common salt is present in purely vegetable food in less amount than is requisite for the body. Moreover, the latter probably contains smaller quantities of proteins, as well as an unsuitable distribution of the other important food-stuffs present. Again, some intestinal disturbance is apt to be brought about by the large proportion of indigestible residues, for instance, the old hard forms of cellulose and the spiral vessels of plants.

To continue the account: A little mild coffee is given. Some patients are advised now and again, for a brief time, to walk bare-footed—especially on wet grass, if it has been raining, and this is said to be strengthening. If walking on gravel, sandals are worn. In certain cases a sun-bath is ordered, and it is given somewhat as follows: The patient, well-protected with a linen head-covering, is laid flat on the grass, and the sun allowed to play on the front of the body for five minutes, then on one side for another five minutes, then on the other side, and then is laid with the front of the body next the grass, for the same amount of time, so that the sun can play on the back. Thus the whole bath takes twenty minutes, which is quite long enough. Then the whole body, and especially the back, is gently rubbed for a few minutes, and the patient goes to bed for a rest, and, probably, a sleep; after which he or she awakes very much refreshed. Sun-baths are very stimulating; they sometimes evoke a rash, and cannot be taken safely more than about once or twice a week, and even thus seldom only with great care.

The above may serve as a brief and rough description of a "Nature-Cure" establishment, such as the author had the pleasure of recently visiting at Broadlands, in Medstead, Hampshire.

At some of the American nature-cure institutions, and others (e.g., we believe at Battle Creek), some patients are advised to try fasting for a time. Certainly it seems easier to fast, when one has been living on vegetarian diet. This is probably owing to the acids of the fruits partly keeping the walls of the stomach and intestines stimulated, sometimes unduly so. Also the kidneys act powerfully, and the urine seems to be so acid as to slightly irritate the bladder and urethra. Repletion is sooner attained probably on fruitarian than on other food. From experience, the writer can testify to a kind of feeling of desire to abstain from food whilst so subsisting; and if he had continued longer, that desire might have been partially indulged. In the very primitive state possibly human beings may have partaken very

freely of fruits and nuts, whilst they were in season and abundant, and then, when scarcity supervened, they necessarily had to go without for longer or shorter periods of time. Hence, possibly, this desire for fasting may be partly explained as a reversion to an ancestral condition. In some of the nature-cure places, one is advised to abstain from eating when not requiring or desiring a meal, and several persons in such places and elsewhere have made a habit of taking but two meals a day. Further than this, some even go so far as to fast for as long as fourteen or even twenty-eight days. I have seen a young lady who had fasted twenty-eight days, living merely, as others fasting did, on warm lemonade or other similar warm drinks, or plain warm distilled rain-water. Of drinks, when fasting, they take a large quantity, and live chiefly in the open air, or in rooms provided with plenty of fresh air. It is just possible that, like leguminous plants, they absorb nitrogen, and, perhaps, even carbon, as well as oxygen, from the air, or else it is difficult to see how the tissues can be maintained. The desire for food does not seem to be so great, as to cause any marked difficulty. The tongue is said to become coated with a thick whitish fur, which cannot be removed with a sponge, on or about the second or third day, and the breath also becomes a little offensive. The gnawing feeling of hunger is not felt for long, and in some cases scarcely amounts to more than a slightly uncomfortable feeling of emptiness, which is mainly appeased by drinking warm drinks.

Actual pain resulting from hunger may be said to be rare, and in any case only lasts about twenty hours. It may even not be felt when the body is exhausted by want of food, and general weakness has in consequence supervened. Similarly, the fear of death probably generally disappears some time before the end of life. The feeling of thirst is very different and far more insistent, and it lasts until very near the closing scene.

The uncomfortable feeling of the furred tongue would appear to antagonize the desire for food. This furred condition, however, after a time, which varies in different cases, disappears, and it is said that, when it does so, is the time for breaking the fast and beginning to eat gradually. As a rule, during a fast, the patient is instructed to keep very quiet, and hot bottles are placed in bed to keep the body warm. However, the strong and well-nourished, and those accustomed to fasting, can even take fairly long walking exercise ; but this is very exceptionally the case. We append, with apologies, a sensible article from a newspaper (we are sorry to forget which ; but think it was *The Daily Mail*, *Globe*, *Leader*, or *Daily Chronicle*):—

FUTILE MISERY.—On Saturday night the Italian, Sacco, broke his fast. For forty-five days he has starved himself to amuse the British public. What amusement is found in a dreary spectacle of this sort is not apparent to the plain man. It is not even an exhibition, for it can hardly be said that Sacco exhibits himself in the act of starving. His performance contributes nothing to our knowledge, for this sort of thing has been done before ; and for the same reason it does not even appeal to that strange " sporting " instinct which loves a new record, even if it only relates to the length of time a man can stand on one foot.

So far from being a record, indeed, it has been not only equalled by Succi, but at least twice beaten, once by the Frenchman Jacques, who fasted sixty days in America, and once by a French murderer named Granie. The latter determined to starve himself to death in order to escape the guillotine, and in spite of his warders' efforts to tempt him and to force him to eat, he persevered for sixty-three days, at the end of which time he died. This is the longest recorded fast. There are, of course, fables of infinitely longer fasts, but they are fables only, like that of the Welsh woman, Sarah Jacobs, who, even on the authority of the vicar of the parish, was believed to have ceased eating for years. In order to test the truth, nurses and doctors from Guy's Hospital went down to Lithernenadd to watch this fasting marvel. They did their work only too well, for on the eighth day she died from starvation. Miss Molly Faucher, the New York fasting lady, who claimed not to have tasted food for fourteen years, was wiser than Sarah Jacobs, for she declined the challenge to submit herself to a properly organized test. Sacco is at least above suspicion. He starves himself like an honest man ; but why he should choose to earn his living by slowly dying, and why any one should enjoy seeing him fading into nothingness—these are secrets known only to the public entertainer.

One of the early chief distressing symptoms is a feeling as if the heart were fluttering loosely in the chest, on account of being unsupported by a stomach containing substantial material. After a time this feeling passes off, probably the stomach having, so to say, learnt the desirability, and attained the power, of retaining fluid to support the heart. The mind becomes extraordinarily clear, and I have heard of a Polish professor who fasted chiefly for this reason, because he wished to work out a plan of a series of lectures for a lecturing campaign. This clearness of intellect is not altogether a boon, for it is coupled with, and doubtless partly causes, sleeplessness, and this is apt to be one of the most troublesome symptoms in the fasting patient.

The young lady whom I saw who had fasted twenty-eight days had lost about a stone in weight, and was rather transparent looking ; so far as I can say, her heart was rather feeble, though its beats were seventy-two per minute. Talking rather tried her, and she could not walk vigorously or far. Another lady, who had fasted for fourteen days, appeared to be no worse, but rather better. I think in each case the complexion was improved in appearance. The return to food must be very gradual, and was begun with a few grapes, which were said to taste deliciously. On the whole, I was amazed to see how the fasting had been borne, though it appears to me to be a dangerous experiment, and when the heart seems to the patient to be loose in the chest, there may be a possibility of its ceasing to beat altogether—then or perhaps later. My experience of fasting is not great; but I think prolonged fasts are dangerous. Still, I can only speak guardedly, for it is possible more will be heard of fasting ere long. My advice in the meantime is that it should be done in strict moderation, and for a short time only, with the object of giving the stomach and intestines a brief occasional rest.

A lady who had fasted fourteen days was said to be taking fairly long walks. No doubt savages have at times enforced fasts, and it is quite possible that many people eat far too much; yet, for myself, I feel very

much better when taking regular meals, as a rule, although the mind seems to be more lucid at the time of an occasional short fast. It is true that, sleeping or resting, whilst comfortably settled in the recumbent posture, seems to lessen the need for regular supplies of food. If, on the other hand, one be obliged to sit up through the night, one is better able to do so with frequent supplies of warm drink and food. Again, in sanatoria, where the patients are enabled to stand the constant fresh air by means of constant feeding with warm milk, Mellin's food, and frequent meals, it has been fairly well proved that even excessive feeding, when the stomach can bear it, is not only well borne as a rule, but that some patients so treated really recover from tuberculosis. Hence, the only conclusion that one can come to is that in cases of this latter disease much feeding is right, i.e., when the digestive system can bear it. When from any cause the latter cannot, whether the inability be or be not accompanied by consumption, then much feeding is wrong, and perhaps in some cases a little fasting may be very useful, if moderately and properly and carefully carried out under strict medical supervision. Otherwise undertaken, it cannot but be very dangerous indeed.

One more point in regard to fasting is, that it is possible, especially when one exposes the skin as freely and as much as possible to the air, that nitrogen may be absorbed therefrom, and it is suggested that a vegetarian and fruitarian diet, especially if coupled with prudent exposure of the skin to fresh air, apparently facilitates such absorption by supplying the bacilli which are capable of doing this necessary work for a starving person. It is very difficult to account for the comparatively small loss of weight which occurs after long fasts, unless some such factor is concerned.

Chapter X.

CLOTHING.

Ethnologists hold that human beings first began to ornament their bodies, prior to covering themselves with clothes. No doubt, however, the need for protection against the sun, rain, wind, and cold had its influence as well. The idea of decency was a secondary matter, which was later developed. For example, the Esquimaux walk out covered with thick furs; but when inside their smoky snow-huts they are quite unclothed. In several groups of mankind the women throw a covering of bast over their shoulders to ward off the rain, and the denizens of New Britain place leafy branches so as to hang over their neck and back when doing field-work, on the march, or canoeing. The women of the Caroline Isles, New Guinea, and the Philippines provide themselves with "rain-mantles." The "sitting-leather" is used by the Hottentots and the inhabitants of South and East Africa. Speaking generally, in the tropics, both male and female savages wear a covering over the loins. In climates not so hot, the upper part of the body is also covered more and more completely, as the weather is colder, and also as the nation progresses: also more completely in the higher classes of the nation, better clothing being a mark of position. Both the animal and vegetable kingdoms contribute. In the South Seas, tapa, the beaten bast of the paper-mulberry tree, is used. Bast is woven by the Micronesians and New Zealanders of these South Seas. A similar material is used by Indians, and in Central Africa, where it is got from a species of fig-tree. Hunters and shepherds clothe themselves with skins and furs, which are prepared by beating, smearing, or tanning.

Cosmetics are much used by savages, and for several reasons, but chiefly to produce an effect on others. The skin is painted—often red, the colour of blood. Then marks and scars are drawn on the skin, which is also tattooed, especially on those parts which are prominently muscular. This scarring and tattooing are most developed as a tribal mark and religious exercise by the Polynesians.

The dressing of the hair is also greatly carried out by the Papuans and numerous other negro-groups with curly hair, especially in South Africa. These have most curious methods. The nose is pierced through septum and nostrils, as also are the cheeks, corners of the mouth, and lips. The ears are greatly decorated with ornaments. The teeth are stained, filed, and sometimes some are knocked out. Males obtain their ornaments from the chase—feathers, teeth, and furs. Women get theirs from the vegetable kingdom and sphere of domestic life.

Many feel inclined to believe that our ideas on thc important subject of clothing have greatly improved in the course of civilization, and when one sees the natives promenading the streets of towns like Durban and Pietermaritzburg clad in a sack turned upside down, with holes made in it for the head and arms, one cannot help agreeing in this view. Yet it may be well to question if there be not still room for several beneficial changes in regard to modern attire.

It must, indeed, be admitted that fashion has much to answer for, by pandering to a love of ornament, and so-called beauty of costume, at the expense of utility, and that of hcalth. Not only is discomfort produced by, but even death may result from, a disrcgard of the structure of the human frame. It is also true that in savage tribes is met with a vigour rare amongst the votaries of society. The former are very insufficiently clothed, the latter sometimes very imperfectly, if the functions of the human body are to be well carried on. In fact, it may be said that the wish for adornment was the original chief cause why clothes were first donned, and still remains one of the leading factors which influence the fashion of dress. At any rate, this motive exercises great potency. More serious purposes, as well as the obvious one of decency, are those of protection from external factors, e.g., cold, heat, direct rays of the sun, wind, rain ; storms, with lightning, snow, sleet, and hail ; and other discomforts and injuries. Perhaps the chief use is to act as a safeguard against cold, by conserving the heat of the body. Loss of bodily heat is thus prevented, and when it is hot the body is protected from the heat and the light of the sun. This last feature, warding off of sunlight, may really be partly a disadvantage also. At any rate, sun-baths, in which the body is exposed to the sun's rays, the head and loins alone being covered, certainly have a good effect, if properly employed in suitable cases. In fact, the strength of savages in tropical and hot countries may be partially due to the fact of going about for the greater part uncovercd. Of course, civilized people, especially in cold and temperate climates, really need adequate clothing.

The normal temperature of the human body in a state of health is constant at 98° to 99° F. The air being at a lower temperature, the heat lost is kept up by oxidation processes, which are to a large extent carried on by the muscles : the radiation being small when it is cold, and great when it is hot. Human beings can stand much heat, but not much cold.

Clothes should fit easily, and not so as to cause any pressure or impediment in movement. In men the shoulders bear the main weight of the clothes ; but in women this is not considered so feasible. Hence, they hang from the waist, and this is a disadvantage which should be obviated. Tight corsets arc also a great evil, and the dress generally is too tightly fitting in ladies. Heavy skirts suspended from the waist are a great obstacle to activity, and knickerbockers are preferable. Howevcr, the custom of encircling the hips with heavy skirts is happily now fast bccoming obsolete. Again, skirts should be,

at any rate in walking costumes, so short as to be above the heels, so that they cannot act as sweepers of the streets, and collectors of mud and dirt. The chest, too, should not be pressed by tight corsets and dress bands, for these force down the lower ribs against the heart, stomach, and liver, which last may thereby be pushed below the ribs. The waist, being wider sideways than from back to front, should not be pressed into an oval shape, and if corsets be used, they should be made of stout jean without bones, and be easily fitting.

Materials generally used for clothing are :—

1. Vegetable fibres of cotton and linen.
2. Animal fibres of wool and silk and hair of some animals woven into fabrics.
3. Mixtures of vegetable and animal products.
4. Skins, tanned or untanned, and either with or without the hair.
5. Fabrics coated with indiarubber.

Cotton and linen favour the loss of heat from the body, being good conductors ; but being bad absorbers of moisture, they are apt, when the temperature falls, or when the production of heat is lessened through fatigue, to impede evaporation from the skin, and cause chills.

In regard, then, to conductivity of heat, linen and cotton are best, and woollen goods worst. Hence, in winter loose white flannel underclothes are most suitable, and if the flannel irritates the skin, a linen, muslin, or silken vest may be placed next to it, as the first covering of the flesh.

Now, fabrics hold moisture both in the interstices between the fibres, and also in the interior of the fibres. That which is absorbed by the fibres is called hygroscopic moisture, and it cannot be completely expelled by pressure. Materials from animals, such as wool, and to a less extent silk, possess more hygroscopicity than do those of vegetable origin. That is, they absorb water more readily, and part with it less easily and less quickly. For example, woollen fabrics absorb much more perspiration, and preserve the heat of the body better than any other. Hence, woollens should be put on after exercise, to keep the body warm. Linen and cotton being better conductors than wool, when made damp by sweat, lead to rapid evaporation and chilling. Materials of an impermeable kind protect the body against cold, rain, and wind. Wind blowing against the skin removes the warm air surrounding it, and increases the evaporation of the sweat—both that already in the clothing and that being excreted. By these means the body is rendered cold. Hence, leather and indiarubber, which protect against cold, wet, and wind, are very useful—leather guarding against cold and wind (motor coats), and indiarubber against rain and wind (sailors' coats).

Woollen goods are specially preservative of the body heat. Cotton and linen fabrics are, according to relative weight only half, and according to relative surface only one quarter, as potent in absorbing moisture as wool, which is a very strong absorber. Both wool and silk are bad conductors of heat, and indeed wool shuts off heat in both directions,

so that it is used for the, at first sight, apparently opposite purposes of making cosies to keep the heat in teapots, and of covering up ice to retard its melting. If ice is wrapped in flannel, it is kept cold.

Flannelette is made of cotton, to resemble flannel, so that it is a better absorber of moisture and non-conductor of heat. It is suitable for nightdresses, especially if flannel irritates. Its easy inflammability is a drawback.

Merino is composed of fine wool and either cotton or silk. In choice of clothing, one pays chief regard to warmth in cold weather, and to coolness when it is hot. Warmth-giving power depends on material, texture, number of layers, and colour.

In regard to texture, a loosely-woven fabric prevents loss of body-heat more effectually than a closely woven one. Also, for a similar reason, viz., that the air between different layers retains the heat, there is advantage when it is cold in wearing several under-garments. Furs also, owing to the interstices between the hairs, are preservative of heat. Metals are good conductors ; but glass, wool, furs, and silk are bad conductors. Hence, glass is used for greenhouses, and wool, etc., for clothes, to prevent the dissipation of the body-heat.

The conduction of heat is greatest by linen, and gradually less by cotton, silk, feathers, fur, and wool, and, as above said, especially also varies with the closeness of the weaving. Soft furry fabrics, whether of wool or cotton, feel warmer than closely woven silks and linens. The more layers of clothes there are, the greater, of course, is the number of layers of air in between them, and by this air the heat is retained, for air is a poor conductor of heat. Cellular cloth is made of cotton-fibres loosely woven. The air which is contained in the meshes renders the fabric warm.

If cotton be loosely woven, as in bath-towels, it absorbs even more than closely-woven wool. Flannel absorbs freely and retains. Closely-woven cotton is soon wet through, and the moisture soon evaporates, leading to great loss of heat. Cotton is now rather loosely woven. Wool is too heavy for the tropics, where linen or cotton is more suitable. The Chinese wear a net close to the skin in hot weather, and a thin silken garment over it, so that the sweat does not get into the outer garment, which does not, therefore, stick to the skin. Woollen and other materials, waterproof by impregnation with beeswax or other substance, and yet porous, are best.

Clothes should protect from wind, wet, and injury, not impede movement, not constrict, nor be heavy, nor afford unnatural support. Impediment, constriction, and weight are faults in long and close skirts, tight sleeves, stays, garters, bands round waist and neck, gloves, hats, and boots.

Tightness interferes with the circulation, and leads to change of the natural figure. Garments should not be unduly heavy, and should be suspended from shoulders or hips, and not from waist.

The head should be kept cool, and though we do not believe in wearing no head-covering in all weathers, yet hats and bonnets should

be of a light kind, and not press heavily on the head. Though exact uniformity may be scarcely possible, we deem it wise that there should not be great discrepancy in the degree of protection used for the head—especially in the winter.

The feet should be well booted, so as to be kept both warm and dry. Like hats, boots and shoes should be made to fit well, and, as a rule, hand-made boots can be got to fit best. Boots should be of soft and flexible leather, and the toes should be able to be moved freely inside the boot. The soles should be wider than the foot, and fairly thick, to protect against loose stones, and keep the feet dry. They should be well repaired when faulty. The heels should be broad and low, and certainly not be so high as to cause the weight of the body to be thrown forward on to the arch of the foot and roots of the toes, whereby an ungraceful gait is engendered, and the ankle is kept in its weakest position.

In rainy or snowy weather, goloshes, or indiarubber overshoes, should be worn. If the feet have become wet, they should be placed in warm water, washed, dried, and put into warm socks and slippers or boots.

Gloves, stockings, drawers, and other articles of clothing, coloured with red, blue, or other shades, may irritate those who have sensitive skins.

The heat of the sun is absorbed in greatest degree by black materials, next by dark blue, green, red, yellow, and least by white. The last colour, white, absorbs heat least, and is, therefore, the coolest. Hence, for protection against heat the most suitable tints for garments are successively white, grey, yellow, pink, red, green, blue, and black. White and light grey colours reflect the most light and heat, whilst blue and black absorb most, and also in common with other dark tints they absorb odours.

In order to make clothes incombustible, they should be steeped in a solution of 1 lb. of tungstate of sodium to each 2 gallons of water, or 1 part by weight to every 3 parts of starch dissolved in water.

The stuffing of mattresses should be composed of the leaves of the sea-wrack (*Zostera marina*), or of very clean hair, or wool, or fine hay.

In no case should there be produced a feeling of tightness round the neck, the waist, the legs, or feet; and hats, collars, corsets, dress-bands, garters, strings, and boots should not be such, or so worn, as to cause any pressure. An easily-fitting corset or, better still, a broad band placed around the hips above the crest, may be provided with buttons, to which woollen nether garments may be fastened. It is pleasant in the summer to wear an open-neck blouse; but some ladies are not strong enough to bear the exposure, and in any case the change from them to furs and boas, and back again, is apt to be fraught with danger.

A desire of fictitious beauty should not determine the nature of the dress, either in respect of waists, or in regard to the absence of covering of the neck, shoulders, and top of the chest for evening wear. The custom of such exposure in ladies' evening dress is an unwise one, and,

at any rate in the case of delicate children, the legs should not be left uncovered—especially in cold weather.

No doubt harm is, in the case of weak and tender persons, sometimes caused by a too early and too sudden change from winter to spring clothing; and though many people are so hardened as not to feel these alterations, or rather are able to respond satisfactorily without catching cold, still there are others who are not so successful in their reactions.

It is not advisable to advocate too much warmth or clothing, for obviously the human race does not do well to develop such needs as will bring tenderness. The Fuegians lie down on the ground at night, sleep a few hours, and wake up in the morning refreshed, although the body be uncovered, save with hoar-frost. It is obvious that civilization has greatly limited our powers of endurance, although it is also to be noted that the mortality in savage tribes is often, especially in times of epidemic infectious disease, appalling in its extent.

Moreover, those who bathe every morning early in the Serpentine, even when the ice has to be broken, and, indeed, the huntsmen, soldiers, sailors, and navvies in their ordinary avocations, exemplify the endurance of our hardy race. Indeed, fortitude may be carried to rashness, and such bathing as above, or in the sea in the winter, may produce illness if the bather be not strong.

It has been inferred from studying the size of old armour that civilized man is gradually increasing in height, at about the rate of 1¼ inches in 1000 years.

If engaged in gymnastic exercise, as may be advised for about two hours a day, a special loose-fitting garb should be worn, as is well known and usually practised.

Both wool and silk turn yellow on addition of either nitric or picric acid, and are soluble in strong boiling caustic solutions of soda or potash. Silk is soluble in hot concentrated solution of chloride of zinc, and also in sulphuric acid; but wool is unaffected by either. Sulphuric acid gelatinizes both cotton and linen after a few minutes. Silk and cotton are dissolved by solution of cuprate of ammonia, and linen also, though slowly. Wool only swells when subjected to it. Cotton absorbs odours; but wool does not markedly retain them.

Chapter XI.

SOIL. WATER. WATER-SUPPLY. MINERAL WATERS. BEVERAGES. WINES AND OTHER STIMULANTS.

Soil.

Soil has important bearings on water-supply, burial, sewage, land treatment, in regard to sites for buildings and causation of disease.

Temperature.—At a distance of 3 or 4 feet from the surface the daily variations of temperature cease to be manifested. Even the annual variations are not important below 6 or 8 feet, are very small below 24 feet, and disappear at a depth of about 50 feet. Moreover, as the depth increases, the maximum temperature is later in the year, and in Edinburgh, in trap-rock, the maximum was in January, and the minimum in July. The summer heat travels slowly downwards.

Trees and shrubs intercept the rays of the sun, and also on the other hand check evaporation from the surface of the soil. In winter they render the ground cool and moist, and cool and dry in summer when the leaves are out, because there is much evaporation from the leaves, whereby the air is moistened and cooled, and the ground dried. It is said that the *Eucalyptus globulus* in Algeria absorbs and evaporates twelve times as much water as the rainfall supplies. Forests render both the daily and annual temperature more equable, and also increase the humidity of the air. Grass also makes the soil cooler and drier, and more uniform in regard to temperature. The temperature of earth is taken at depths of 1 and 4 feet. Below the latter the heat rises 1 degree for every 55 feet.

Moisture.—Water occurs on the surface in marshy ground, and at depths varying from 2 or 3 feet to 100 feet or more in other places. Pettenkofer estimated the rate of flow of ground-water in Munich to be 15 feet per day; but the velocity must of necessity vary with the degree of permeability of the soil, the degree of fall, and the amount of obstruction, as by roots of trees, shrubs, and other obstacles. The range of rise and fall of the ground-water varies from a few inches to several feet. When it rises, air is forced out of the pores of the soil. It may bring into wells the washings of impure soil when it rises, and a fall may also act perniciously, by leaving the soil moist and aerated, the air being sucked in from above, and so prepared for fermentation and putrefaction, if the material for those processes be present.

Air is present in all rocks save the hardest (which *contain water instead*) above the ground-water, and loose sand may contain 50 per cent of it. It is mixed with moisture, and sometimes contains NH_3,

H_2S and CH_4, being also mixed with animal or vegetable organic matter. It contains excess of CO_2, which increases concurrently with the depth, whilst the O is small in quantity and decreases with the depth. It constantly moves owing to wind, rain, changes in temperature and pressure, rise, fall and flow of ground-water.

Chemical Composition.—Dead animal and vegetable matter are constantly being added, and then removed by putrefaction, nitrification, and the influence and action of vegetables and animals. Nitrates are generally found in the soil of all parts that have been inhabited for any length of time. Impurities from soil, even from so-called "made soil," are at length removed by oxidation and rain, especially if freely exposed to wind and well drained.

Soils contain especially the following elements, viz., oxygen, silicon, aluminium, calcium, magnesium, sodium, and potassium. Of the various kinds of minerals only four enter largely into the formation of rocks, viz., quartz, felspar, hornblende, and mica. Rocks may be igneous, aqueous, or sedimentary and metamorphic. The first and the last of these, namely, the igneous and the metamorphic, are chiefly composed of silicates, carbonates, and oxides. It may be said here that features of a soil especially influencing climate and health are: (1) Conformation and elevation; (2) Amount of vegetation; (3) The character and amount of the contained air and water; (4) The temperature and power of absorbing or retaining heat; (5) The nature and number of the micro-organisms in it.

Micro-organisms in Soil.—There are many bacteria contained in soil, and they are specially numerous for a few inches from the surface, and the more the soil has been polluted, the more numerous they are. The number diminishes in accordance with the depth, and below a depth of twelve feet there are but few. The superficial and moist layers contain more micrococci, the deeper and drier portions more bacilli. Some species of micro-organisms are widely distributed, whilst other occur only in limited areas. Many spores and bacilli are present in soils. Micro-organisms may be saprophytic (productive of decomposition), or pathogenic (productive of disease). Some saprophytes oxidize, some de-oxidize, some possibly acting in both ways under different conditions. Those which oxidize are the most numerous and important, and include those which carry out nitrification. Nitrous and nitric organisms are distinguished by specific characters.

It is probable that pathogenic bacteria are as a rule soon destroyed by the saprophytic. In the deeper layers of the soil are found the spore-bearing species. If the soil be moist, micro-organisms have usually a better chance to survive; but peat, on account of acids contained in it, is detrimental to them. Winds may blow about bacteria-impregnated dust from the top of very dry soils; but in this country such transference is only possible in the summer and autumn hot and dry weather. Water, too, may convey bacteria from soil, and Dempster showed that the bacilli of cholera can be carried through two and a half feet of porous soil by a current of water.

The denitrification organisms are very numerous in soils which contain much organic matter, which they convert firstly into ammonia, and then into nitrites and nitrates. Compounds of ammonia and of nitrogen are split up into free nitrogen, carbonic acid gas, water, ammonia, and nitrites. This decomposing action may be stopped by passing the vapour of chloroform into the soil, the chloroform paralysing the micro-organisms. Moreover, the soil must be alkaline, the carbonates of potash and calcium, and lime and magnesia being usually present. A temperature of 37° C. is most suitable, and the soil must be moist and contain air. Not only is the organic matter oxidized into nitric acid, but also the carbon is, so as to form CO_2. These processes are the work of the nitrifying bacteria, organisms first discovered by Schlösing and Muntz in 1877, and further studied later by Warrington.

There is firstly the oxidation of the ammonia compounds into nitrites by the nitrous organisms; and secondly, the further oxidation of the nitrites into nitrates by the nitric organisms. For the performance of their special work these organisms require pabulum, O, a base with which HNO_3, when formed, can combine, and a suitable temperature. Both the nitrous and nitric organisms are widely distributed in most soils within about a foot of the surface, and they act in conjunction. In organic solutions nitrous organisms thrive and nitric ones do not, whilst in inorganic solutions containing nitrites the nitric organisms abound. The presence of peaty or humous material seems to preserve the vitality of nitric organisms during the fermentation of NH_3-bodies. There is also another group, the so-called nitrogen-fixing bacteria, found in soil, and especially in that surrounding the roots of leguminosæ and in the roots. These fix free N (symbiosis). This may also be done by the leaves, or by the soil. In this way leguminous crops, e.g., clover, vetches, peas, and beans, increase the amount of fixed N in the soil, and especially if it be at first scanty therein; by the nodules which grow on the roots and rootlets, and also by the roots themselves. These bacteria break down organic matter and animal products, oxidize sewage, and fix N from the air.

Pathogenic organisms of several kinds flourish in soil, making it infectious. There is the *Bacillus tetani*, which is often present in the soil and dust in certain districts, either as bacilli or spores. Its presence in jute factories is perhaps due to its attachment to the roots of corchorus in the soil in Bengal. The bacilli of quarter-evil (symptomatic anthrax of cattle), anthrax, tetanus, typhoid, cholera, and diarrhœa may be found in soil. Eberth's bacillus produces typhoid, a vibrio causes cholera, and the *B. enteritidis sporogenes* probably evokes summer diarrhœa in epidemic form. Some streptococci also may occur in a soil. The spores of anthrax, typhoid, and tetanus may remain therein for a prolonged period. The typhoid bacillus, according to Sidney Martin, survives in dry, sterilized garden soil for 404 days.

If sewage be placed on ordinary garden soil, sewage microbes increase

at the expense of soil microbes ; but the latter at last lead to the death of the former, though in sandy soil this process takes some months. Sewage bacteria include indol-producing bacteria, gas-forming bacteria, spores of *B. enteritidis sporogenes*, *B. coli* and its allies, and streptococci. Luckily soil can destroy pathogenic as well as ordinary sewage bacteria. Anthrax, tetanus, malaria, enteric fever, cholera, diarrhœa, and yellow fever are connected more or less closely with the condition of the soil. Dampness is favourable to phthisis and diphtheria, and perhaps rickets. Goitre has some connection with the soil.

Pettenkofer, from researches conducted mainly at Munich and Leipsic, held that enteric fever and epidemic cholera are due to (1) A rapid fall after an unusually high level of ground-water ; (2) Pollution of soil by organic matter; (3) A certain height of earth-temperature (4) The specific organisms in the soil.

In these ways a warm, moist, well-aerated soil supplies the necessary conditions for the microbe. Yet it is not merely a fall that causes the fever, for in England outbreaks have occurred with rising ground-water. Malarial diseases are due to specific protozoa which pass one of their stages in the soil or in the surface water, and they require air, warmth, moisture, and decaying vegetable matter. A rise in the ground-water, caused by rain or lack of outflow, often causes an outbreak in malarious parts, and these can be freed from malaria by thorough drainage, or by a permanent flooding of the marshy part.

Enteric fever, cholera, diarrhœa, and yellow fever flourish where the soil is polluted with animal matter. Ballard holds that summer diarrhœa has correspondence with the earth-temperature at a depth of four feet. Proximity to marshy and especially malarious ground is dangerous. Buchanan held that the phthisis mortality is increased by dampness of the soil due to rise of ground-water, and that when the soil is dried by artificial drainage, it falls 30 or even 50 per cent, and also that there is less phthisis in populations living on pervious soils, high and sloping, than on impervious, low and flat soils. Damp, cold soils favour rheumatism, bronchitis, and pneumonia. If the ground-water be within five feet of the surface, it is apt to be injurious, and it should be fifteen feet or more below. Frequent and extensive fluctuations of the level are more dangerous still. Clay in the soil renders it cold.

Building Sites.—Porous soils such as sand or gravel, with low ground-water, are warmest, but also most liable to organic pollution, and the ground-air moves freely in them. Clay is better than sand or gravel containing organic matter, for in the latter the impure ground-air is formed constantly out of the soil, and drawn into the houses. If the ground-water be also high and fluctuating, this liability is still greater.

The most healthy spot is the summit of a slope of which the soil is pure sand or gravel, with low and stationary ground-water. The foot of a slope usually receives the drainage from the high ground, and is generally damp. The winds pass up the valleys from the lower to the higher levels during the day, and in the reverse way at night. Herbage and trees are beneficial, but the latter must not interfere with light

and air. Irrigated lands, and especially rice-fields, which give off organic matter and much moisture, are dangerous, and in Italy these fields are not allowed within 14 kilometres of cities or 1 of small towns. Well-managed sewage farms are not injurious. Made soils should be avoided, especially if they contain excrement or other organic refuse, and if in hollows wherefrom drainage and aeration are impeded, and also in cases where they have been deposited for a less period than three years.

Water.

Two-thirds of the weight of the body is composed of water. If no fluid be ingested, death occurs in a few days. The amount actually requisite varies with the work done, and also with the temperature. At least 2½ pints are needed, and most healthy adults take in about 4 pints or more daily, nearly one-third of this being contained in the solid articles of diet, and the rest in liquids; or, according to others, about 3 pints are taken in the form of fluid and from 1 to 2 pints in the solid food. It is believed that water is not absorbed either by the skin or by the stomach, though half a pint will pass through the pylorus to the duodenum in half an hour. Water, which should be purified by boiling before ingestion, does not increase tissue-waste, but merely washes out waste products from the body. Hence it should be freely taken in cases of gout, renal diseases, diabetes, and fevers. In obstruction of the pylorus, saline enemata should be given.

Water may be the carrier or mode of introduction of many poisonous and deleterious matters. Hence it is very requisite that pure water should be supplied, and indeed this should be one of the chief objects of consideration by the sanitary authorities, as very serious dangers spring from any lack of care in this respect. The provision of water has always been a matter for anxious care, not only of cultivated but also of uncultivated races; and this need of an adequate supply also accounts for the localization of nations. The immense canals and irrigation-works of ancient nations, especially the Romans, are marvellous.

Much has been accomplished and is being accomplished to improve the water supply, especially of the larger towns and cities. Speaking generally, the water we drink nowadays is much superior to that which our progenitors consumed. It is, indeed, nothing less than wonderful to observe how careless our ancestors were, and even some people nowadays are, in this respect; and assuredly we ought to feel most thankful that we live in a wiser and more scientific age. Yet we must be careful not to be content with the progress already made, for indeed there is still much room for improvement. About 25 gallons per head is daily supplied in most of the towns in Great Britain.

The source of water is the rain, this being absorbed from the humid parts of the earth, seas, lakes, and rivers. Part of the rain is again evaporated, and part again deposited in streams and lakes. Another portion sinks into fissures in the soil, and collects on the surface of any

impervious stratum encountered, whence it either again emerges in natural springs, or can be gathered in wells. The proportion of rain which sinks is 90 per cent on sand or gravel, 40 per cent on chalk, 20 per cent on limestone, and very little on clay. It is naturally less on hills, because the declivity makes it run down to a lower level; and it is also less in summer than in winter, because there is more evaporated in the hotter weather. The proportion which sank on a gravelly loam was 2 per cent in summer and 100 per cent in winter.

Rain-water is soft and well aerated. Its purity depends on that of the atmosphere. If carefully collected in the open country in perfectly clean receptacles, it is generally almost pure. The waters of elevated parts are often soft, and therefore suitable for washing and brewing; but they may contain organic matter—generally of vegetable origin. Rain falling near the sea may often contain chlorides and sulphates. More inland, where human beings are present in greater number, it contains more sulphuric acid, ammonia, and organic matter, owing to putrefaction and to the combustion of coal. In and near towns it may even be acid, owing to sulphurous and sulphuric acids, and contain tarry and carbonaceous matter. It gets from the air O, N, CO_2, NH_3, and a little HNO_3, as well as organic matter. Water may be clear and brightly sparkling and possess a pleasant taste, and yet be impure, just as fresh cold air is not necessarily pure. As well as to water itself, attention should also be paid to springs, wells, rivers, streams, reservoirs, cisterns, and water-pipes.

Springs and Wells.—Rain, as it sinks into the ground, dissolves CO_2 from the air in the vacuities of the soil and lime and mineral salts, as well as organic matter from the upper layers; but the organic matter is filtered off, or oxidized by the O in these top layers into nitrates. However, water in shallow wells often contains much organic matter from the soil, some of it oxidized into nitrates or nitrites and chlorides. In districts where there is peat, the water may be brown, and may contain so much vegetable matter as to cause diarrhœa in those who drink it. Water from deep strata may be warm.

River-water comes partly from springs, but chiefly from that part of the rain which runs along the surface of the soil or near it. It contains mineral salts in solution, though in less amount than spring or well water. All streams contain organic matter from manured land or farmsteads, especially after heavy showers. Hence river water should be filtered before use. Some, however, is oxidized by the air, and some removed by aquatic plants. Bacteria may be greatly reduced in number by oxidation, dilution, sedimentation, light, and also by other organisms; but when sewage is added in excess, self-purification of rivers is not possible except in a slight degree. The refuse of dye- and bleach-works and paper-mills decolorises the water, and makes it still more turbid than even sewage. Worse still is the refuse from slaughter-houses and that from privies.

Mode of Supply and Transference of Water.—In rural districts water is obtained from streams, springs, wells, and stored rain-water.

Shallow wells may supply good water, unless they are in proximity to leaking cess-pits, ash-pits, drains, or dwellings. Water collects in a kind of natural reservoir under the ground, above the first impermeable stratum, and a well must reach to its level. A well may draw in polluted material from places some distance off. If a cess-pool be on a hill-side, even at a distance of 200 feet or more from a well, it may, by an underground current passing in the direction of the well, infect its water. Hence it is requisite that precautions should be taken to prevent leakage into wells. Far more harm has been and is caused by faulty wells than is generally realized. Care should be taken that no cess-pits or drains should be in the vicinity of a well. The writer has frequently observed serious leakage into wells, which, when the ground-water and springs are low and the wells therefore rather dry, doubtless exert very great suction power on all surrounding fluids. In fact cess-pools should not be allowed near either houses or wells, nor should there be any filth near ; but if such be unavoidable, they certainly should be not any nearer than twice the depth of the well. The latter should be as far as possible from any cess-pit, whether of the same or any adjoining residence, and it should be on a higher level than the cess-pit, so as to render any transference of filth less easy. As an additional protection, a well should be lined with brick, which should extend about two feet above the ground. Outside the brick there should be a space left which should be puddled with clay. If the water obtained be impure or insufficient in amount, the boring should be extended downwards more deeply. If the water lying deeply is under great pressure, it will overflow at the top when thus tapped, and so give rise to an artificial spring, or so-called artesian well. Borings into the sandstone or limestone give large and constant supplies, but wells in the superficial sand or gravel beds or chalk often fail in times of drought. Abyssinian tube wells may be driven even to 150 feet deep in gravel, coarse sand, or chalk. They are not advisable for clay, marl, or fine sands, and cannot penetrate rock. Rain-water may be collected from roofs and any impervious surface.

Collection and Storage.—Water is collected in reservoirs at such a height as to allow of distribution by gravitation through pipes or aqueducts leading to the street mains, and thence to the service-pipes. Pumping may be necessary to gain the required height. Settling-tanks and filter-beds are also usually requisite. The water is obtained from deep wells, springs, lakes, rivers, streams, or artificial drains from gathering grounds. Reservoirs should be capable of holding at least 150 days' requirements. In the driest year rain will be about one-third less than, that in the wettest about one-third in excess of, the average of twenty years. The best water is obtained from deep wells, or that collected from barren highlands.

Reservoirs.—These may be excavated or made by carrying an embankment across a valley. The banks are constructed of clay backed by stone on the inside, and covered with growing grass on the outside. Tributary streams, liable to be foul in flood-time, should be diverted.

The reservoirs have an overflow weir, and are made capable of being emptied for cleaning, by laying down a pipe leading from their lowest point. They should be about 19 feet in depth, and either two or more separate ones should be made, or else, what practically amounts to the same thing, should be double, i.e., consist of two or more separate parts, so as to allow of one portion being emptied and then thoroughly cleaned, without interruption of the supply. They should be covered, so as to prevent the entry of the excrement of birds and other sources of contamination, but not excluded from free access of air. Fish and aquatic plants assist in purifying the water. The outlet pipe is so placed as to avoid sediment being drawn in on the one hand or floating particles on the other. It therefore begins at some little distance from the bottom of the reservoir, and passing upwards, leads to the aqueducts, which may be open channels, or iron pipes buried three feet in the ground, so as to be protected both from sun and frost. These pipes are lined on the inside with hot pitch, coal-tar, vitreous glaze, or other non-corrosive substance. Barff's process consists in heating the iron pipe to a white heat, and then passing superheated steam through their interior. Magnetic oxide of iron, Fe_3O_4, is thereby produced. Means of access are made here and there to allow of cleansing The mains then pass beneath the streets, and are provided with "scouring-valves" at the dead ends, wherefrom sediment can be washed out. Water-mains should be placed as far as possible from sewers and gas-mains, as there is danger of in-suction of gases and fluids, if a descending pipe should become perforated, especially at a point of constriction, and this, too, even if they be always full.

Water-pipes near drains exert this sucking-in power if there be holes in their walls, or faulty joints, and also to some extent even through minute pores in their material. For this reason an intermittent service is especially dangerous, because, when the pipes are empty, they are much more liable to draw into them coal- or sewer-gas or liquid filth. With the view of lessening or preventing such pollution, drains should be laid far away from water-mains and with an adequate fall, and they should be sufficiently large to conduct the sewage without great congestion, water-tight, and fitted with traps. Sewer-pipes are liable to leak at the joints, unless these be properly cemented, and they may be broken by accidental causes, e.g., settling down of walls or sand or gravel beds, or perhaps opened at weak points by rats. Pipes of terracotta and earthenware are to some extent pervious, and, even if made of iron jointed with lead, are liable to rust rapidly and corrode. Hence there is always some danger of soakage of filth around the pipes, and this, if near the water-mains, may corrode their walls and be drawn inside.

The service-pipes which lead to the houses are controllable by a stop-cock for each house. The pipes inside the houses are generally made of lead, but iron pipes may preferably be used, and if the water is such as dissolves lead, that metal cannot safely be employed. Rain-water which has been carelessly collected often contains organic matter,

and it is very capable of dissolving the lead from any channel or receptacle, and hence should not be transmitted by, nor stored in, leaden articles. Water should not be conducted from a roof nor from a spring in leaden pipes.

Cisterns.—Rain-water, if to be stored, should, after leaving the separator, be filtered through sand. Cisterns are used for keeping it, and they are also of course necessary when a public or other water-supply is intermittent, also for water-closets. The material of which they are made may be stone, cement, brick, slate, tiles, or some metal such as iron, zinc, tin, or lead. Lead especially, and in a less degree zinc and iron, are liable to be partly dissolved by water, which therefore becomes poisonous. Cisterns for drinking-water should not be made of, nor lined with, lead, and it is best also to avoid zinc and copper. The freer the water is from ordinary impurities, and especially if it be from moorlands and contain peaty acids, the more lead it is capable of dissolving. Slate is probably the best material for a cistern, but has the disadvantage of liability to leakage, unless very carefully cemented with good cement or Spence's metal. Brick or stone lined with cement may be used, but must not be set with ordinary mortar, because the lime in it is taken up by the water, which thereby becomes hard. Iron is not really suitable either for cisterns or pipes, as it is liable to be rapidly corroded, and the water rendered rusty-looking and unpalatable. To prevent such action, iron, if used, should be coated internally with Portland or patent cement, or a vitreous glaze. Galvanized iron tanks are useful, and, like all other cisterns, should be protected from excess of heat and light, and well ventilated, as well as free from risk of leakage, and also from every possible source of contamination. It is important to see that no overflow-pipe be connected with a soil-pipe, or a drain serving to convey refuse fluid from sinks, water-closets, or baths. Such pipes should end freely in the air above ground, and discharge their overflow into a trapped grate. A small independent cistern should be relegated to each w.c., and on no account should a cistern for other purposes be used to supply a w.c., for contamination of its water may thus easily be brought about. A cistern containing water for consumption should be quite separate and not near those used for other purposes. Cisterns should have well-fitting covers, so arranged that they can be readily removed to allow of inspection and scrutiny. Convenient access should also be provided, as they need to be often looked after, and should be emptied and cleaned out every quarter.

Purification of water may be necessary on account of excessive hardness, excess of salines, suspended material, organic matter, or contamination by germs of disease. Distillation is practicable even in the case of sea-water. However, distilled water does not taste nice because of want of air; but this can be added by making the water fall through a sieve, or by forcing CO_2 into it. Distilled water, to which carbonic acid has been added to make it palatable, is supplied by the Salutaris Company.

Boiling, especially if Na_2CO_3 be added first, removes temporary hardness, destroys bacteria, and causes some of the organic matter to be carried down with the lime. Boiled water also, like distilled water, should be aerated to remove the flat taste. Hard water may be softened, and also deprived of all suspended material, both organic and mineral, by the addition of about six grains of alum per gallon, whereby $CaSO_4$ and a bulky precipitate of aluminium hydrate are formed, and these carry down the suspended matter with them. Or one ounce of quicklime for each degree of temporary hardness may be added. The precipitated chalk is then removed by rapidly pressed filtration through a cloth.

Filtration.—By this process hardness is lessened, as also are the nitrites and ammonia, but the amount of nitrates is increased. A filter may be made of six to twelve inches of fine sharp sand, an inch or two of small gravel, and a layer of animal charcoal, which is better than vegetable charcoal.

Dr. Parkes' cottage filter is thus prepared : Get a common earthenware flower-pot, and cover the hole with a bit of zinc wire gauze, or of clean washed flannel, which requires changing from time to time ; then put into the pot about three inches of gravel, and above that the same depth of clean white sand, washed very clean. Four inches of animal charcoal (covered with a thin stratum of coarse gravel, or with a piece of slate to keep it in place) constitute the last layer : and the water should be poured in on the top, and be received from the hole at the bottom into a large glass bottle. The charcoal will, from time to time, become clogged, and must then be cleaned by heating over the fire in a shovel. The sand and gravel must also be renewed from time to time.

Some prefer silicated carbon, manganous carbon, or magnetic carbide of iron, or carferal (a mixture of charcoal, iron, and clay) ; or powdered charcoal and lime may be placed on an asbestos layer. This last, like other animal charcoal filters, also removes lead. However, charcoal, by supplying N and phosphates, aids the multiplication of bacteria ; and it may also absorb impurities from the air. Pasteur-Chamberland's filter is composed of porcelain formed of a mixture of kaolin and other clays. It is good, as also is the Berkefeld, which is made of infusorial earth. Periodical sterilization of all filters is necessary. Filtration of water on a large scale is done by filter-beds. These are shallow reservoirs containing about two feet of water, drained at the bottom by perforated or loosely-jointed pipes, the water passing down through successive layers of fine sand, coarse sand, oyster shells, fine gravel, coarse gravel and pebbles—these together comprising several feet. Vents from the deeper layers extend to above the surface of the water, to let the air out. Occasionally the beds are left dry, and sometimes the sediment and superficial sand are scraped off, and fresh sand is added. The sand checks from 95 to 99 per cent of the micro-organisms. A gelatinous film soon collects on the surface of the sand, and it is in this that the process of nitrification of organic

matter and the arrest of the bacteria occur. The effluent should not contain more than 100 microbes per cc., and the number of bacilli coli should be counted. If water be taken from a river, that after heavy rains should be excluded. It should be first purified by passing through a subsidence tank, and floating material should be excluded by admitting it through a submerged sluice.

Great risks may be encountered when travelling away from home, because it is not always easy or even possible to take necessary precautions. When it is suspected that the water supplied is not good, as when one is in an unhealthy district, or when an epidemic is raging in a generally healthy one, danger may be obviated by first carefully filtering and then boiling the water. Good filters should be used, and one should see that they have not been contaminated by having previously filtered bad water. The sediment, if any be present, should be thrown away, and the water briskly boiled for half an hour or longer, shortly before being drunk.

Examination of Water.—A Winchester quart bottle is first rinsed with a little HCl, several times with plain water, then with the water to be tested, filled with the same up to the neck, the stopper being then tied on. The gathering ground should be examined. A label is then fixed on with the date, time, and conditions of collection, and address. Water should be clear and bright, free from turbidity, odour, or saline or other taste. Looking through a column of water two feet in height on to a white surface, it should appear clear, or a little green or blue. If a yellow or brown tint be seen, organic matter is indicated. Water may contain *suspended* parts of animal, vegetable, or mineral origin, living organisms, animal and vegetable, including microbes; also *in solution*, gases, mineral salts, and soluble organic matter, animal, vegetable, or both.

Suspended Matters.—Allow the water to stand in a tall glass for a day, and examine the sediment with the microscope. Particles of sand are seen to have a sharp outline. Fragments of chalk and pieces of clay are amorphous; but a drop of acid placed under the cover-glass will dissolve the chalk, leaving clay unacted on. Shreds of cotton and linen are easily detected, and so are vegetable fibres, leaves, hair, wool, bits of insects, epithelial scales, and brown globular bodies due to sewage.

Living Organisms in water may be rhizopods, infusoria, hydrozoa, rotifera, scolecida, entomostracæ, insecta, fungi, algæ and diatomaceæ. A large number imply the presence of much organic matter. There may also be parasites, e.g., tæniæ, guinea-worm, dochmius duodenalis, and leeches.

Mineral Salts.—Not only is water liable to contain living organisms and organic matter, but also inorganic salts. These include chlorides, sulphates, carbonates, silicates, nitrates, nitrites and phosphates, of calcium, magnesium, sodium, potassium, aluminium, or iron, and rarely lead, zinc, copper, manganese, or arsenic. Rain and pure moorland water contain almost none, but there may be 3 parts per 1000 or more in mineral waters or those near the sea. A good

water should not have more than 1 in 10,000, and not exceed 4 for drinking.

Frankland spoke of all the inorganic N present in a water, whether as nitrates, nitrites, or ammonia, as due to previous sewage contamination. Lime, or rather calcium, is the most important mineral component. It occurs chiefly as bicarbonate and sulphate, and in a good water there should not be more than 20 parts per 100,000 of the former, nor more than 5 of the latter. When in great amount, it causes constipation if drunk, and is wasteful when used for washing. If used for washing, it should first be boiled, so as to deposit the lime. Soft waters are not so palatable as those containing a small amount of lime, which indeed is required for the bones ; and they also dissolve lead from lead pipes and vessels. Sulphate of calcium causes permanent hardness, i.e., such as is not removed by boiling, and is injurious. Nitrate and butyrate of calcium have been found in waters causing diarrhœa.

Iron is not infrequently present naturally, and some waters contain much. It may be derived from pipes or tanks, the sofest water acting most readily on iron pipes. Water is not potable if it contains more than 1 gr. per gallon or 1·5 pts. per 100,000. Iron adds to hardness, and it causes dyspepsia and headache in those not used to it: but in small amount is harmless, and may even be beneficial.

Lead, though rare in natural water, is not infrequently added from lead pipes or cisterns. The lead unites with the O dissolved, and, especially if the water be acid, the oxide of lead is dissolved, or is suspended as a fine powder. If the water contains chalk, this is deposited on the lead, and prevents solution. Hence, well or spring or river waters, which, as a rule, contain chalk, do not dissolve lead ; but rain and soft moorland water do so. Rain water, containing organic impurities and carbonic acid, acts powerfully on lead, dissolving it in the form of the carbonate. The peat of moorlands imparts an acid reaction which favours the solution. Nitrates, chlorides, or CO_2, also aid, but silicates and other substances retard it.

The acid-reaction and consequent plumbo-solvent effect of some moorland waters is due to acid sulphates, to sulphurous or other acid in rain, or to humic and ulmic acids found in soil, or excess of carbonic acid, or to the acid of peat caused by bacteria. Houston has shown that micro-organisms of peat, when added to a sterile decoction of peat, render the latter acid and plumbo-solvent, and he has isolated two non-motile and non-liquefying bacteria from peat which possess this power. Acidity is greatest soon after rain, which washes out the acid accumulated in the peat. Still, if $CaCO_3$ be absent, the power of dissolving lead is possessed by many neutral and even slightly alkaline moorland waters. Tidy and Odling thought the power of dissolving lead is due to the absence of silica. Even distilled water, or distilled water containing Na_2CO_3, will dissolve lead.

In order to prevent plumbo-solvent action, water has been exposed to fragments of limestone, but it soon becomes inert owing to incrustation.

Quantities of lime, about 2 or 3 grs. to the gallon, have been added. Powdered chalk or whitening ($1\frac{1}{2}$ gr. to the gallon) is better, or 500 gallons, containing 1 lb. to the gallon of soda, may be added to 1 million gallons of acid water. Houston advises sand-filtration, with a little lime on the surface of the sand, and limestone underneath it, and the subsequent addition of a trace of Na_2CO_3 to the neutral filtered water.

Many waters are protected by their salts. Sulphate of calcium is less potent in this respect than the carbonate, and magnesium less than calcium. An incrustation is deposited inside lead pipes, consisting of carbonate and sulphate of lime, lead, and magnesium, and chloride of lead. Carbonate of lead is only slightly soluble, except in water with excess of CO_2. New pipes, those bent, and those alternately full and empty, are more strongly acted on, and water which has remained long in the pipes contains more. Hence it is best to let such water off, before drawing off for drinking. The purer the lead, the more strongly is it acted on. Lead pipes can be lined internally with block-tin, or less reliably with tar or bitumen. Iron pipes may be lined with tin or glass, or with Angus Smith's varnish and collodion, or they may be galvanized, or the rustless Barff iron pipes may be used. Besides letting the first portion waste, all water used for drinking or cooking should be filtered through a filter, which contains animal charcoal as well as sand and gravel. The phosphates contained in such charcoal form an insoluble lead salt. Lead causes anæmia, constipation, colic, paralysis of the extensors of the hand (wrist-drop), a blue line along the edges of the gums (owing to sulphide of lead), optic neuritis, abortion, gout, and disease of the kidneys.

Zinc, Copper, and Arsenic, though rare in natural waters, may be found therein owing to trade effluents, or by the water dissolving them from pipes and vessels, especially if the water contain organic matter, nitrates and nitrites.

Hardness is caused by salts which prevent lathering of soaps, until enough soap is added to combine with them. The amount of salts of calcium and other metals is greatest in spring-water, and next largest in that of rivers and streams. That from the green sand and that from the new red sandstone are the softest derived from deep springs. Water derived from the chalk formations is hard, containing often about 17 gr. of carbonate of lime per gallon.

The report of the Water Supply Committee of the House of Commons set forth that "moderately hard water, the hardness of which is due to the presence of carbonate of lime, when used for drinking, is not injurious to health. Persons, however, who are accustomed to soft water may suffer by changing it for hard, and *vice versa.* But when the hardness is due to sulphate of lime, it is objectionable."

The chief salts are those of calcium and magnesium ; but iron and aluminium act similarly in causing hardness. If the water be boiled, the free CO_2 and that of the bicarbonate of calcium is driven off, insoluble carbonate of lime being formed. Bicarbonate of magnesium is similarly reduced, though it partly re-dissolves on cooling. Most

of the iron is also precipitated by boiling. All that thus disappears by boiling is termed temporary hardness ; but sulphates of calcium and magnesium, chlorides, and a little iron, if present, remain. These, together with the re-dissolved carbonate of magnesium, cause permanent hardness. Now soap is composed of oleates, stearates, and palmitates of alkalies, which form a viscid solution with water ; but with the above-named metals form insoluble oleates of calcium, magnesium, etc.

Salts of calcium and magnesium have been supposed to cause goitre, which, notably in India, seems to be found only where magnesian limestone is found. However, it is not always nor exclusively found there. Some think it is caused by iron pyrites and other salts of iron and copper, often found where there is limestone, and some that it is due to an organic material or organism. Goitre seems to have been caused in about nine days with some waters. Potable water should not contain more than 4° of permanent, or 20° of total hardness.

Organic matter in solution consists of animal and vegetable matters, and the products of their decomposition.

Bacteria in Water.—In all surface-waters bacteria are abundant, and they are often present in deep-well and even spring waters to a small extent. The three groups, viz., micrococci, spirilla, and bacilli, are all present in water, the last being most numerous, and multiplying rapidly. If a sample of ordinary water be allowed to stand for two or three days, enormous multiplication, even up to a million per cc. may have occurred. Then diminution will occur, and in three months there may be few or even none left. Deep well water contains only from 1 to 10 per cc. River water varies in the number of bacteria very much. In the wet year 1903, in June, unfiltered Thames water contained 10,337 per cc., and in December 27,216. These numbers were reduced by filtration to 42 and 37 respectively. The number of course depends on the place of collection, whether polluted there or not, on natural self-purification, on time of year and amount of rain, and on the degree of swiftness of the current or flow. If the flow be tardy, there is time for subsidence. The amount of organic matter contained in the river depends on various obvious factors. Also the time of the day, the temperature, the amount of sunlight, and of exposure of the river bed to the external air, exercise their influence. For instance, if the river be sheltered by high, overhanging banks, trees, or shrubs, the influence of sunlight in destroying germs is to some extent lessened, and other modifying changes are brought into play. For a water to be potable, it should not contain more than 100 microbes per cc., and no pathogenic ones. Different species of bacteria are (1) Ordinary water-bacteria, including fluorescent bacilli, liquefying and non-liquefying, many of the ordinary chromogenic ones, and those of air and soil. These are not pathogenic. (2) Sewage bacteria, e.g., *Bacillus coli communis* and its allies, the proteus family, *Bacillus enteritidis sporogenes*, and some streptococci and staphylococci. Streptococci present in water denote pollution by sewage, as they are absent from pure water and virgin soils. (3) Pathogenic bacteria, e.g., the bacilli

of typhoid fever and cholera. These are only scantily and seldom found, and when present may have come from the gathering grounds, or from sewers, or from houses. All other impurities of water are of relatively less importance than these germs, which are liable to cause cholera and typhoid fever respectively in those who consume water containing the one or the other kind of microbes. So terrible are these scourges that the utmost care should be taken to prevent the virus of either gaining access to any source of water, and this can only be done by the greatest care in regard to drainage and water-supplies.

The famous tea-water pump in Broad Street, near Golden Square, London, is supposed to have furnished the means of killing 500 persons with cholera in a single week during the epidemic of 1854. The water of this pump is said to have contained about 5 or 6 gr. of lime to the gallon, and it was highly valued for making tea, since this amount prevents the solution of certain astringent principles of the leaf. One old lady who took refuge in Hampstead sent her maidservant every day three miles for a kettle of water to the Broad Street pump, and this old lady and her maid were the only persons attacked with cholera in Hampstead. The officers of health at length removed the pump-handle, and the consequence was that the pestilence notably decreased in the neighbourhood. It was afterwards proved that the water of this well was polluted by the soakage into it of discharges from the bowels of cholera patients who used cess-pits in its vicinity. The same kind of causation has often been traced in regard to typhoid fever, diphtheria, and other diseases. It is very important to remember that if cholera, cholera infantum, typhoid fever, diarrhœa, or dysentery appear without known cause, there is probably something wrong with the water supply, the milk-supply, or the drainage.

Moreover, apart from the possibility of their leaking into wells, drains should always be attended to with the most scrupulous care by those who are specially skilful in such matters, lest there should be exhalations of sewage gas into any rooms of dwelling-houses. However, drainage is much more thoroughly carried out than was formerly the case. It is not now usually the case, as it once was, that supplies of water should be submitted to all kinds of impurities, by the effectual method of direct or indirect leakage from cesspools, drains, and other like sources of deadly pollution.

Gases in Water.—One litre of water may hold in solution 25 cc. of O, 46 of N, and 1000 of CO_2 at the ordinary temperature and pressure. These may be extracted by a Sprengel pump, or by boiling for an hour, and collected over a trough containing mercury. The CO_2 can then be absorbed by potash water, the O by K pyrogallate or Na hyposulphite, and then the other gases, N, H_2S, CH_4, NH_3 will be left, or such of them as are present, H_2S being due to mineral sulphides such as iron pyrites, or to decomposition of sulphates by organic matter, CH_4 to fermentation of vegetable matter in pools, or to coal gas. NH_3 in traces is generally present. Water from wells or springs in chalk is usually well aerated with CO_2, and therefore lustrous and palatable.

Results of Examination of Water.—Examination should include that of the gathering ground, source and course of the water, and mode of supply, besides a chemical, microscopic and bacterioscopic investigation. The sediment should be examined with the microscope. Chemical analysis should have regard to the gases, mineral salts, and soluble organic matter. Pollution by vegetables is far less dangerous than that by animal matter, and it may be often recognized by the slowness of the evolution of albuminoid ammonia, by the absence or small amount of chlorides and of free NH_3, by microscopic characters of the sediment, and information as to the source. On the other hand, an animal origin of the organic matter is to be inferred if the albuminoid ammonia evolves rapidly, or if there be excess of chlorides or oxidized N. However, if effluvia have been absorbed, or if animal material has gained access, there will not necessarily be any excess of chlorides.

It is wise to recollect that a water may be pure at any given time, and still be liable to pollution now and again. Minute but dangerous pollutions by enteric, choleraic, or other virus cannot be detected by chemistry, which can only prove impurity and not safety.

Bacteriological examination can show (1) The number of bacteria per cc. ; (2) The organisms of pollution ; (3) Those of disease. The metropolitan water generally contains less than 20 bacteria per cc. The organisms which imply contamination are certain liquefying bacilli, *B. coli*, *B. enteritidis sporogenes*, and streptococci. If the *B. coli* can be found in 2 cc. of a water, it has probably come recently from sewage. Houston regards water containing streptococci as recently and dangerously polluted. Of course the presence of any pathogenic organisms, such as *B. typhosus*, or the cholera bacillus, in however few number, constitutes a deadly danger. However, such organisms can rarely be found, the bacillus of typhoid only living in water for a few days.

A water should be condemned if (1) It contains very many germs ; (2) It contains *B. coli*, *B. enteritidis sporogenes*, streptococci, or any pathogenic organism ; (3) It gives the enteritidis change in milk cultures, or ferments glucose or lactose media.

Vegetable matter in suspension or solution may cause diarrhœa, though a small amount of dissolved peat, even if imparting a brown tinge, is harmless.

Animal matter from cesspools, drains, farms, manure fields, animal tissues, or absorption of effluvia, is dangerous. The products of simple decomposition of animal matter may produce diarrhœa and alimentary and constitutional troubles. In tropical countries polluted water often causes dysentery, both sporadic and epidemic. Many sudden localized outbreaks of diarrhœa in Great Britain have been caused by water polluted by effluvia from sewage alone. Such pollution often increases, and percolation through soil will gradually lose its power of purification through the soil becoming saturated. Moreover, the way is open for the germs of cholera, enteric fever, dysentery, and parasites, if those disorders arise. Finally, goitre, plumbism, rickets, and urinary calculi may possibly be connected with the water-supply.

Beverages.—Pure hot water has been recommended to be taken with meals or after them, especially by elderly people, and if any feeling of oppression is felt after eating. Pure water at a temperature of about 120° F. pleasantly aids digestion and facilitates healthy peristaltic movements, and may be made more palatable by adding a teaspoonful of concentrated infusion of orange peel to the tumbler.

Aerated Waters may be preferred. The CO_2 in them stimulates the stomach, but as it is rapidly absorbed by the wall, they are unsuitable in marked cyanosis, as also where distention of the stomach is dangerous, e.g., in cases of gastric ulcer, or cancer; or cardiac debility.

Aerated waters are of two kinds, viz. (1) Original Seltzer and Apollinaris and other waters, and (2) Artificial, as soda, potash, or lithia waters, lemonade, and artificial seltzer. These latter are charged with CO_2 under pressure, and usually contain alkaline salts, such as carbonate of sodium, which renders them able to dissolve more CO_2. Lemonade contains citric acid and sugar, and the acid dissolves lead if that metal be present. Only the best kinds of aerated drinks can be relied upon, i.e., those which are manufactured with the utmost care from the purest waters.

Before resorting to any spa for the mineral waters, one should consider the journey, the climate, the daily routine involving change of habits and trouble, and the nature of the particular water. The properties of the latter are sometimes so strong, that one should be careful not to take too much. Dr. Gardner pointed out long ago that the introduction of salts into the system may at first supply a need, but afterwards, if persisted in, acts deleteriously, and even poisonously. He speaks of a fatal result having occurred from excess of seltzer water having been taken.

Other Non-alcoholic Artificial Beverages.—Tea contains theine, some volatile oil, tannic acid, gummy matters, etc. An ordinary teacupful of tea infused for about five minutes, or of black coffee, contains 1 gr. of tannic acid, and 1 or 2 gr. of theine. *Coffee* contains caffeine (which is the same as theine), tannic acid, and an oily substance, caffeol, which last makes coffee unsuitable for gastric disorders. *Cocoa* contains a small amount of theobromine (allied to caffeine), also 26 per cent of fat, 12 per cent of proteid, about 25 per cent of carbohydrates, and 4 per cent of ash. It is slightly nutritious.

Tea and coffee are, by reason of their caffeine and volatile oils, stimulating to the nervous system and heart; remove feelings of fatigue, and are therefore useful in exhaustion, but increase tissue-waste. They are also suitable for opiate or alcoholic coma and certain febrile conditions; but unsuitable for nervous, sleepless, or excitable people, and those with palpitation or indigestion.

Intoxicants are obtained from various animal and vegetable substances by means of fermentation. Kava is obtained from the root of a pepper-bush in the South Seas; the negro prepares pombe beer, and in North America there is the maple (elder) wine. Less harmful are the tea and coffee of Asia, which stimulate but do not

depress, unless used immoderately or wrongly. Tobacco-smoking and snuff-taking are religious customs of the Indians, and allied habits are the smoking of dakka and hemp, the eating of betel by the Malays and in the Indian sphere, and the chewing of koka by the Peruvians and other South American tribes.

Fermented Liquors, such as beer, ginger-beer, wines and spirits, koumiss and kephir, contain varying amounts of alcohol. A solution of grape-sugar, to which is added the yeast plant (*Saccharomyces cerevisiæ*). the temperature being from 20° to 30° C., is mainly split into alcohol and CO_2, the equation being :—

$$C_6 H_{12} O_6 = 2 C_2 H_6 O + 2 CO_2.$$

Spirits.—Brandy is obtained by distilling wine. Rum is produced by distilling fermented molasses. Whisky results from distilling malted grain.

Wines.—These are made from the fermented juice of grapes. Cheap wines are made from other fruits, and wines are often fortified and adulterated in various ways. Home-made wines and cider are sometimes made and stored in earthen vessels coated internally with a glaze made of litharge, from which they partially dissolve the lead, and become dangerous on that account.

Beers.—These were formerly made from malt and hops only, but now they are often made from starch and sugar and various vegetable bitters. Pure beer is the fermented liquor got from the germinating grain of barley ; but the glucoses and invert sugars which are now used instead of the malt are got from rice and other starches by acting upon them with diluted sulphuric acid, and as the latter sometimes contains arsenic from the iron pyrites employed in its manufacture, poisoning by arsenic occurred in beer consumers, especially in the north-western parts of England, in the winter of 1900–1901. Some invert sugars contained 2·04 grains of arsenious oxide per pound, and some beers even as much as 1 gr. per gallon.

Wines and other stimulants, though they can by healthy persons be dispensed with, are undoubtedly at times beneficial, when used properly and in moderation. There can be no question as to their great utility when prescribed for suitable cases by the medical attendant. Indeed, some forms of disorder, e.g., of bronchitis, sometimes really need stimulants. However, more than this may be claimed, for, when the purity of water is a matter of doubt, a small quantity of good spirit in it may act as a partial protective against disease. The writer has tried both total abstention and the moderate use of a stimulant, and believes from experience that for many people no harm is caused by taking about two fluid ounces of port, sherry, Marsala, or Madeira at dinner, or if preferred half a fluid ounce of good whisky, rum, brandy, or gin. On no account should double that amount be exceeded by anyone, nor should anyone become so accustomed even to the smaller quantity, as to be unable to do without it. If there be real need, then, stimulants may be taken to improve the appetite and digestion ; but one should be careful not to become addicted to the

habitual use of spirits or wines or beers, for a healthy person can as a rule very well do without any of them. Still, if indigestion should rather abruptly arise, as from an over-heavy meal, especially if taken hurriedly, or at a time of great exhaustion, or from a too early commencement of mental or physical work after it, a little whisky or brandy with warm water may be useful. These are beneficial, too, if there be diarrhœa, spasms, or a chill springing from exposure to cold or wet, or any marked depression of the vital powers from any other cause. For instance, during very severe wintry weather some persons, especially if elderly or weak, may have cold feet, and artificial heat may not only not give relief satisfactorily but may produce chilblains. In some such cases half a fluid ounce, or even an ounce, of rum, brandy, or whisky with hot water may be taken before going to bed ; but care should be taken that the spirit be pure, or a headache or foul tongue may occur in the morning. Caution should always be exercised in regard to even such small doses of alcohol, and the same also applies to tobacco-smoking. It is quite true that a man may *feel* better whilst thus indulging, but the belief of the authors is that in most cases one would really get on just as well, and in many cases better, without either the one or the other in even small amounts. Still each case should be judged on its merits, and there are many points to be considered.

Chapter XII.

CLEANLINESS AND BATHING—CHANGE—REST—RECREATION—SLEEP AND SLEEPLESSNESS—EXERCISE AND EXHAUSTION—THE ACTION OF THE LUNGS AND SKIN.

Bathing.

It is often truly said that "cleanliness is next to godliness," and it is equally obvious that this necessitates frequent ablutions of the surface of the body, and a due regulation of the excretions. The former is not sufficient without the latter, for it is just as important that the interior of the body should be clean as that the skin should be. Regular habits, therefore, in these respects should be acquired, for health largely depends upon these essential matters. Much can be learnt from some of the ancient nations. The Romans, for instance, were well acquainted with the advantages derivable from baths, and it is just possible that in some instances they, like others, may rather have bathed too much than too little. Hence and for other reasons the reaction came, and bathing fell into unmerited disuse for a long period, but it has now again revived. In the reign of Augustus the baths of the Romans were large, splendid, and beautiful buildings. They were very much used, and much of the day was spent therein by the bathers. The same prolonged stay is also practised by the Turkish ladies now in their baths.

The baths of Agrippa, Antonius, Caracalla, Diocletian, Nero, and Titus were vast structures, and those of Diocletian were particularly grand, being wonderfully constructed and capable of being used by 1800 bathers at a time. The vestiges of some remain, which are nearly 2000 years old, and the modern so-called Turkish bath is constructed in a similar fashion, but of course on a much less imposing scale.

The buildings were adorned with images of their gods, and hence the early Christians were prejudiced against them, their realization of the foolishness of the Roman worship probably blinding their eyes to the benefits of the baths, wherewith that pagan worship was supposed to be connected. Speaking generally of the different kinds of bathing, one may say that it aids in the removal of dirt and infectious or unhealthy material from the skin. This partly consists of excreta, partly of any other extraneous matter which has collected thereon. The aged, and such persons as have atheromatous arteries,

or those who do not readily react after a bath, cannot be often safely bathed, except with great precautions.

Each kind of bath, whether hot, tepid, or cold water be used, should be specially prescribed by the physician, and if the Turkish bath be selected, very strict precautions as to regulating the method should be enjoined. It is usually the best in all cases to commence with a warm shower, and the amount of heat, submitted to, need not be large, whilst for aged persons it should only be small. Indeed, bathing should always be well regulated. In cases where it is thought best to dispense with bathing, once a week at least even the elderly may act wisely in applying a sponge or flannel dipped in warm water and soap to the whole body twice or thrice, and then quickly drying with a rough towel. Some prefer the morning, and some the night, just before getting into bed, for this measure, and many do it both night and morning. The aged should not be advised to practise this every morning, but those who can safely do so will find it very refreshing. For those who cannot bathe in the morning, a warm bath before going to bed is very beneficial. The vessels of the skin may be trained to react to variations of temperature by following the hot bath with cold sponging of the body, whilst the feet still stand in the warm water. The sponge, with not much cold water in it, is quickly passed all over, and thus a healthy glow is aroused. This results from the constriction of the blood-vessels of the skin. The dilatation, previously caused by the heat, is instantly removed, and the bather greatly stimulated. Some prefer tepid water baths, and speaking generally it may be said that very good effects can be obtained by judiciously carried out bathing, but that special care in this matter is requisite for the old.

A foot-bath of hot water, to which a tablespoonful of mustard is added, may be very advantageous when the blood-vessels of the head are congested, causing headache, and when a person is sleepless, or has cold extremities. Some prefer cold water for the feet.

Local Hot-water Baths act locally for the chief part. Local hot dry-air baths and also the application of radiant heat are sometimes useful, if properly applied according to prescription.

Vapour Baths.—The temperature in these is not usually high, as they range from 99·5° to 133° F. Perhaps the best way is to evaporate water by means of a spirit lamp, or a steam kettle may be used. The patient must be properly protected from too direct a contact. The body temperature rises on an average about 2·5° F. The pulse and respiration are greatly accelerated. A loss of weight of from 100 to 900 grams may occur during vapour baths lasting from half an hour to two hours. They are very useful for chronic rheumatic and allied ailments. If there be arterial sclerosis, vapour baths and indeed all baths should be only used with the greatest caution, for they cause a great deal of stress on the circulatory system.

Before entering the cabinet, the skin should be moistened by means of a sponge which has been dipped in warm water and squeezed out.

This renders the skin more liable to perspire, and hence the heart is not so powerfully stimulated. Cabinets are sold at from 30/– upwards. The effect is nearly the same as that of the Russian bath as given in Turkish-bath or other bathing establishments; but it is more suitable for invalids, as it can be taken at home before retiring for the night. The travelling to and fro is obviated, and with it the danger of catching cold, as also is that of taking infection from other people using the same public bath. Vapour baths are apt, especially if too hot or too prolonged, to cause a feeling of lassitude the next day, due to enfeebled circulatory power, and are therefore injudicious for very weak people.

Sun Baths act beneficially on tuberculosis. At Veldes, in Austria, the sun and air cure—a clothesless system—has been carried out by A. Pikli with good results, but there are some unavoidable risks in exposure of the body. Huggard reports good results also from exposure of the body to direct sunlight for two hours daily, but thinks the action is mainly on the general health. Marti has shown that light or any other mild stimulation of the skin increases the number of red blood cells, whilst absence of light or violent irritation causing inflammation diminishes their number. Light has a potent influence, and no doubt atmospheric electricity also has. The sun bath is of great benefit, if properly used in suitable cases.

The Electric Light Bath.—The cabinet, though larger and round, is on a similar plan to that of the wooden vapour bath, though for vapour baths as a rule an indiarubber material is now used. Numerous electric lights are arranged around the interior. The skin may be moistened with tepid water before one enters. The temperature goes to about 160° F.; but it is the light which has the best effect, as it penetrates through the skin and acts on the internal organs. Copious perspiration is caused, and this without any great circulatory stress. The secretion, when analyzed, is found to contain mercury, arsenic, and other substances which may have been taken by the patient years previously, and is therefore very valuable as an eliminative process. After the bath the patient should be sponged and rubbed down, and rest some twenty minutes or an hour. A wonderful feeling of exhilaration ensues.

The Turkish Bath.—Before entering the hot rooms, a warm shower should be given, and then the patient may gradually go from the less hot to the hotter rooms. In the dressing-room the temperature is 60° F., that of the first heated room is 110 to 120°, the second being heated to 150°, whilst the hottest ranges as high as 250, 260, and even 300° F. Most people will find this much too high, and even those who are strong enough to bear it should only attempt to do so in the best ventilated baths, and with the skin already moist, and in any case should only remain in for a few minutes, for otherwise there may be considerable danger to the system, especially the heart and brain. A violent action of the heart is caused by so high a temperature, and unless the room be exceedingly well ventilated, as is unusual, there is grave danger from these very high temperatures. From repeated

personal experience, the author would beg to insist on the essential of good ventilation, such as for instance is to be found in the baths in Leicester Square, London. It is wisest to consult a physician conversant with the subject before indulging in the luxury of Turkish baths, and learn how best to take them.

Subjection of the whole body to hot, dry air is followed by shampooing (wet massage), scrubbing with soap, and warm and tepid douche. Turkish baths are very valuable when properly used.

Mud, Peat, and Sand Baths.—These can now be had at all well-equipped spas and bathing resorts. Undoubtedly, when well managed, they are extremely advantageous.

Mud baths are chiefly made of inorganic substances, of which silicic acid is the main component. Some organic matter, too, is present.

Peat Baths.—In these organic matter is the chief element, but there is also inorganic material.

In both mud and peat baths there are many fine, hard particles present, either sand, fragments of shell, or hardened bits of plants and trees. By these the skin is greatly stimulated. Peat and mud being worse conductors of heat than water, both higher and lower degrees of heat can be borne. The mud may be used locally as a hot poultice or pack, and as an ordinary bath to the whole body. Massage may be used during the bath. Tepid douches remove the mud or peat.

Sand Baths.—The heat is dry, and varies from 118° to 125·6° F., or if only locally applied, to 133° F. There is nothing to prevent free evaporation from the skin. A full bath may last as much as forty-five minutes, a half bath may last as long as sixty minutes, and a local bath as much as ninety minutes. The skin is very greatly stimulated, and the internal temperature rises from 0·9° to 4·5° F.

These baths are useful for chronic inflammatory exudations, chronic rheumatism, muscular contractions, and stiffness of joints.

Radio-activity of mineral waters is now being much considered.

Through the unbroken skin there is no absorption except of gases, volatile substances, and substances mixed with some fatty material if rubbed in.

Cold Baths cause contraction of cutaneous vessels, whereby the blood is sent to internal parts. The breathing is at first gasping, and then becomes slow and deep. The pulse is slower, whilst the nervous system is stimulated. After the bath the pulse and respiration become normal in rate, the cutaneous vessels dilate, and this causes a feeling of warmth. A shower bath, in which the water can be gradually cooled down, is beneficial. Sometimes a sponge, dipped in cold water and then squeezed, may be more easily used than a bath. A *Warm Bath* causes dilatation of the vessels of the skin and perspiration, increased rate of respiration and circulation. It is very useful for cleanliness and after exercise, and for producing sleep.

Speaking generally, the whole body should be bathed at least once, and in most cases twice a week, throughout the spring, autumn, and winter, and at least every alternate day in summer, and if the whole

body cannot be bathed, at least the arm pits, groins, feet, and toes should be cleaned, as well as the hands and face.

The best time for a bath for people who are liable to take cold or are otherwise weak is at night, just before getting into bed. A tepid, warm, or hot bath at that time is very helpful in causing sound sleep. Others may find it more agreeable to take a bath at about 11 o'clock in the morning, after digesting breakfast.

It is a good plan, after exposure to cold and wet, or after hard exercise or work, to have a warm bath, and then be wrapped in warm blankets in bed. Cold baths are good for the robust only, and should be taken with care, and not persisted in, if there be no glow or feeling of warmth in the skin soon after drying. Tepid or cool sponging acts generally as a good tonic, and is best done in the morning or at night, or at both times.

Baths should not be taken immediately after a meal, nor during exhaustion from fatigue or excitement, nor during nor just previous to menstruation, and they should be sparingly used by pregnant women. Children and elderly persons ought to employ warm or but slightly cool baths, never below 70° F. In nervous persons, and especially those who suffer from valvular disease of the heart, cold baths of any kind, and especially sea baths, should only be resorted to with the most extreme caution.

Fortunately for the inhabitants of the British Isles, they can, without much trouble, time, or expense, repair to the seaside, and utilize the advantages of a stay there.

In looking also at past history, we find that the appreciation of sea air is no new thing. Thus Aretæus recommended sea voyages, and a residence at the seaside in cases of phthisis, and Celsus, like Aretæus, extolled the curative powers of sea climates and sea voyages. In the present day it is not only in England that seaside resorts are becoming more popular, and more completely supplied with every necessary and luxury. In South Africa, where the temperature of the sea water is much higher than in England, the good effects of sea-bathing* are well known, and it is becoming more customary, we believe, for the inhabitants of Cape Town and its suburbs to spend a few weeks annually at the seaside in such places as Kalk Bay, Blue Berg, Somerset East, etc., and even in skirting the coastline in the steamers which ply between Cape Town and Durban, it is by no means uncommon to find people camped out in some of the beautiful, almost unfrequented, and most picturesque spots on the strand. Indeed, it is well known that all over the world people living in inland districts are glad to stay near the sea for a time, there to inhale the fresh and revivifying air emanating from the expanse of the ocean, there to forget troubles, anxieties, and worries, whilst hearing the soothing sounds of the waves, as they roll and ripple and

* One should be very careful as to sharks, which are in these parts very numerous, and come near shore at times. When visiting a South African sea-side resort, the writer was told of three young ladies who had swum too far out and had been devoured by these voracious creatures.

roar on the beach. There is no more majestic sight than the sea on a wintry moonlight night, the silver luminary riding high in sky, and casting down her piercing beams upon the surging waters and on the glistening sand.

If one goes down to the seaside for a week or a few days, or even a single day, the health may be much improved, a fresh start being given. Some persons, however, feel worse, especially at first for a few days, higher elevations suiting them better than places at sea-level. For those likely to suffer from rheumatism, the constitution may be strengthened, but that particular disease will not be benefited. It may indeed be made worse. The reasons may be the humidity of the air and the salt contained in it, but there are other causes, such as the poor quality of the water often found at marine resorts, which is sometimes brackish. Besides this, the land close to the sea is not infrequently marshy and badly drained, and sometimes the sanitary conditions are defective. In warm weather, those who are careful in selecting their residence in regard to all these conditions may receive very great benefit, especially if staying some long time. The writers have found a very great superiority of air by living in a canvas tent on the beach. Under such conditions a really pure air is breathed for the whole day and night, and if one can put up with the little discomforts and lack of room, it is really astonishing how greatly one is benefited.

Of the customs generally considered conducive to health, one of the most useful, if rightly employed by those for whom it is suitable, is sea-bathing. It strengthens the system, and hence arrests or prevents disease, or restores vigour that has been lost in the course of disease. The advantageous effects are stimulant, tonic, antiseptic, and it is also beneficial for certain affections of the skin. Numerous factors are involved, for example the constant impact of the moving sea-water, the action of the various salines and constituents of the same, and the play of sunlight on the skin, also the deep breathing of the pure air which at once takes place.

Sea-bathing is thus seen to be one of the most powerful means of stimulating the nerves of the skin and the whole body, as a result of the coldness of the water, the blows of the waves, and the composition of the water. However, it is only suitable for fairly strong people, and must be carefully carried out. A sea-bath should not be continued longer than five minutes or so as a rule, except in the case of vigorous persons well accustomed to the practice, and able to bear it with advantage. No more effectual stimulus than sea-bathing can be found, and the good it does is really marvellous. If properly carried out, there are no evil consequences such as result from indulgence in alcoholic or some other stimulants. Yet it must be mentioned that special risks, e.g., sharks, render it dangerous at times. Drowning, if care be exercised, need scarcely be feared, but the weak and the unhealthy cannot stand the shock of exposure to the cold water, and it should be remembered that the sea-water may be cold even in summer time. In such people the reaction may not occur, and instead of it depression

may ensue. For the many who for these reasons cannot safely bathe in the sea, warm sea-water baths indoors may be advised. These are supplied at many seaside places, and can be prepared in one's own house, if need be. Tepid sea-water swimming baths are also to be found here and there, and at Southport is a luxurious one in which it is really a great treat to bathe.

People who have weak circulatory power, and those who are anæmic, should not as a rule bathe in the sea, but if they suffer from merely mild disturbance and are well supplied with fat, they may do so with care, according to the directions of a medical man, in which case it may be curative. It may be also good, if similar precautions be taken, for children in whom a tendency to "pasty scrofula" is seen, provided they are well nourished and due care be taken.

The sea varies in regard to (1) The temperature. In the German Ocean, during the time in which bathing is customary, it varies from 60·8° to 65·2° F. (2) The saltness of the water. In the case of the German Ocean the salts are present in the proportion of about 29 grams in the litre. (3) The motion of the water. The movements of the water and the force of the waves are far more energetic in the German Ocean, as in all seas which have considerable ebb and flow, than is the case in the Baltic, with the exception of a few places whereat the shores descend steeply. (4) The air—its composition and pressure.

The remaining and taking exercise in the open seaside air, the removal from household and business cares, the altered diet, and so forth, are all beneficial factors. Now the stimulus supplied by the application of cold to the skin produces both directly and by reflex action a contraction of the cutaneous vessels. In this way the loss of heat is evidently diminished. The diminution of the calibre of the vessels of the skin causes the temperature of the skin to sink rapidly. It causes also a determination of blood to the internal organs, and therefore sea-baths, in like manner with cold baths, should certainly not be employed by such persons as are inclined to internal hæmorrhages, such as for instance from the lungs, stomach, brain, or other organs or tissues. It is possible also that the greater amount of blood supplied to the internal organs may bring about a more active conversion of tissue, whereby the production of heat is somewhat increased. Certain it is that immediately upon a loss of heat at the surface there is a great increase of production of heat, together with an increase of the excretion of carbonic acid gas, and also of consumption of oxygen. The greater the stimulus of cold on the skin, within certain limits, the greater are those three augmentations.

Change, Rest, Recreation.

One's occupation should be selected in accordance with one's tastes and desires as far as possible, for congenial work is far less trying to the constitution than such as goes against the grain. Inclination for a pursuit generally implies at least some adaptability to it.

A certain amount of change, too, is beneficial, and travelling may

be advantageous in opening fresh chances of observation, and so widening the point of view.

A due amount of rest and also of useful recreation should be taken, for prolonged monotony of work, especially if combined with worry, as it often is, is a cause of degeneration. Worry is generally caused by ill-health, overwork, and repeated failure to gain what one works for. Hence change, rest, and some recreation are of great service. Indeed a periodical abstention from labour may be said to be essential.

Recreations, which at once elevate the aspirations and keep up healthful activity, conduce to self-control. Active and wholesome work is health-giving, and the indolent do not as a rule reach a ripe old age. Anxiety is depressing, and prosperity is encouraging.

For any great achievement much work is needed. Only those, who have tried to accomplish great tasks, fully realize this fact, for labour is plentiful and cheap, and any ordinary toil is as a mere nothing nowadays. No doubt many are wearied out, and even perish from the strain of over-work and anxiety, and for these the writer would counsel patience, abstention from hurry, more rest, perhaps, too, in some cases, rather more change. Monotony is burdensome, and hence Sundays are very helpful. Self-denial is essential for happiness and for health ; but a point often lost sight of is that this applies to work as well as to play. It is well to bear in mind that repose is necessary, but that health cannot be gained by mere inactivity and rest. A change of occupation indeed may be far more salutary.

Exercise, Walking, and Exhaustion.

The direct consequence of the assumption of the erect posture was that the arms and hands took on the function of manipulation, whilst the legs and feet were developed and reserved for locomotion. The use of sticks and stones as weapons would imply new mental activities. This first great change is called the early upright stage, and it was followed by the palæolithic, then by the neolithic, and then successively by the historic stages.

Walking should be free, as the Scotch and Zulu women walk. The chin should be held slightly upwards. If the head be held downwards, the weight of the body being thrown on the chest compresses the lungs. The toes should be turned outwards. The hands should swing freely and lie behind the body, and when one is sitting the spine should be pressed against the back of the chair. Girls' dresses should not be tight. Boots should be made to lace, and hand-made purposely to fit the wearer, but not heavy, with thick and broad soles. The heels should be low, as high heels cause an ungraceful and difficult gait.

Exercise in the open air is beneficial, and indeed an essential condition, for the well-being of the system. Be cheerful, and select congenial pursuits so far as possible, for depression is a great cause of lowered vital activities. Obviously the best health is desirable, so that all duties may be performed as well as possible. Some knowledge of the laws of life should be acquired, in order to rightly regulate conduct.

For example, the whole time should not be given up to study, for one of the conditions of health is that all parts of the body, and not the brain only, should be duly exercised. This rule cannot be entirely ignored, without throwing the constitution out of gear. By the sweat of his brow shall man live. This decree is not merely biblical, but also endorsed by scientific authority, and yet it is often neglected, for, in proportion as civilization advances, it becomes more and more difficult for those sedentarily employed to comply with this injunction as to the necessity of physical work.

Every organ needs moderate use, and either excess or deficiency alike leads to degeneration. The exercise of the voluntary muscles is especially necessary, and their action not only aids the circulation and the heart's activity, but also the formation and, later, destruction of the blood. Exercise occasions an acceleration of the circulation of blood in the lungs, the amount of air inspired and of carbonic acid gas exhaled being also much augmented.

Though sedentary habits may become more fixedly established, and that of bodily exercise be comparatively neglected, apparently at times without impairment of the vital force, still those who keep their bodies in good order with healthful activity will be best able to do good mental work without injuring themselves.

Unless some other form of exercise be preferred, or found more suitable for any given person, a healthy male adult should take a walk daily lasting for from half an hour to three hours, according to the degree of vigour possessed. A female will not require so long a walk, for whilst a male may find about five miles right, a woman might be content with, say, three or four miles. Some say a mile daily should be walked for every stone, but this would only apply to the vigorous. Once a week, however, the distance may be extended, and the time allowed as much as five hours. If so many hours cannot be given to this pursuit, at any rate benefit will be derived from even a little such exercise. It may generally be held that about two hours, daily spent in some active exercise such as walking, riding on horseback, rowing, cricket, golf, fencing, or other healthy outdoor pastime, will be found very advantageous. Mental work, too, will be vastly improved by it. Once a year a walking tour lasting some three or four weeks is also to be advised for those who can safely undertake it.

Babies and young children should not be allowed to walk too much, especially if their bones be tender, and some children will sometimes attempt more than their strength allows. In regard to children, even crying may be of use in exercising the muscles of the chest.

During exercise the pulse is quick, small, and at times irregular, and even intermittent, if the exertion be either excessive or prolonged. If there be either irregularity or intermittence of the beat, or difficulty of breathing, or merely fatigue of the body, the exercise should be stopped, so as to give the heart, the lungs, and the nervous system time to recover regularity of action. Not only is the circulation

increased, but also the respiration. During an ordinary work-day, the amount of oxygen absorbed is one-third greater, and the amount of carbonic acid gas eliminated two-fifths greater, than during a day of inactivity. The amount of water given off by the lungs and skin on a work-day is two and a half times as much as on a rest-day. An excessive amount of exercise, as well as a deficient amount of it, are harmful, the latter causing excitability.

During exercise the cutaneous vessels dilate, whereby heat is radiated from the skin, and it is also lost by evaporation of the perspiration. In the latter are salts, especially chloride of sodium, as well as fatty acids and other organic substances. The temperature of the body may rise 1° F.; but if the rise be greater, there is danger. Woollen clothing is best for exercise, because of its small conducting power for heat.

The appetite, especially for proteids and fats, is improved, and absorption is quicker, whilst lack of exercise causes diminution of appetite and power of digestion. Exercise diminishes the amount of urine, owing to increased loss of moisture through the skin and lungs. Its inorganic salts are increased, but urea is not, and may even be diminished.

Although we would not dream of protesting against so fascinating and useful a pursuit as cycling, still it is certain that too much may be done, and that reckless riding is a very dangerous habit for several reasons, not only to others but also to the rider.

Further, when riding in motor cars the eyes should be protected against the rapid currents of air. They should, when necessary, also be similarly guarded against the glare of the sun on the snow.

A fairly active life is necessary for health, and it is difficult to maintain it in some professional careers. Aggregations of primitive men begin to rise in power and importance, largely in proportion as they possess, and use, the skill necessary for utilizing the soil and its productions. Gradually, as they become more and more highly civilized, the simpler arts are practised and sought after diligently. At length, as generation follows generation, the pursuit of agriculture unfortunately comes to be rather looked down upon, left to be dealt with by those who, from incapability or disinclination, are not fitted to rise to the higher positions. The result is the frequent neglect of the active life and of exercise.

The bodily functions should be well balanced and equilibrated one with another. It is not generally realized how necessary this point is. The body should be exercised as well as the mind, the mind as well as the body should be employed and considered, and the aim should be to preserve a healthy mind in a healthy body. In these days we are much too often confronted with the indisputable fact that whilst many human beings scarcely exercise the mind at all, living purely by he results which accrue from bodily activity, others on the contrary never exercise the body, but live entirely on the rewards of mental work, which last is often required in excess. Of the two

mistakes the last indubitably is the greater; but unfortunately many persons are almost compelled to make it in these days of ardent competition. There is a tendency in this age to a superabundance of mental work, and frequently the best is the worst paid of all orders of work. Fathers of numerous children should reflect upon this great question very seriously indeed, before they take in hand to determine the pursuits and professions for which they design their sons and daughters, and see that they do not neglect their bodily frames. They should remember that a weak and well-balanced body is for all intents and purposes a practically stronger body, than a vigorous one which is not well balanced.

Exhaustion.—If guinea-pigs be worked on a tread-mill until they die, and then the juice be expressed from the exhausted muscles and injected into the veins of fresh guinea-pigs, these become fatigued, their eyes bulge, and in a period varying from twenty to forty hours they die. Dr. Weichardt says this is due to fatigue-toxins, and that if a very little of these be injected into a fresh animal or human being, an excessive amount of the anti-body is produced, whereby prolonged exertion can be taken with more ease. He also says that with rest the fatigue-poisons disappear owing to oxidation, and that senile decay is due to accumulated fatigue, and diminished oxidation. Metchnikoff has also held that antitoxins might be prepared to prevent the senile deterioration of cells. Belonovsky holds that if the hæmolysins—which poison-serums, when in some amount, destroy red corpuscles—be injected in very minute doses, they stimulate the production of these same cells, and hence they have been used in cases of anæmia. It is noteworthy that guinea-pigs can resist about 2½ gr. of opium, whilst rabbits succumb to a much less amount, unless gradually accustomed to the drug. However, rabbits can resist belladonna very successfully.

The Action of the Lungs and Skin.

The skin carries out exchange of gases in extent about one-thirtieth as much as do the lungs, its pores absorbing a little oxygen, but sufficient to keep the skin more or less red, and giving out a little CO_2, whilst of water they set free 1 pint daily, a quantity twice as great as the ½ pint daily given off by the lungs. The composition of ordinary air and expired air is thus :—

	Ordinary Air.	Expired Air.
O	20·96	16·4
N	79	79·19
CO_2	0·04	4·41

The sudoriparous glands which give off the perspiration open into the pores situated between the hairs. On each side of a hair there is also a sebaceous gland which opens just beneath the skin. The best wash for the face is pure rain-water; and the skin should not be rubbed off. Plain curd soap or oatmeal soap or other bland kinds are far better

than the stronger or irritant sorts. If there be blackheads on the face, they can be pressed out, either with two finger nails or with a watch-key.

If a hand be placed in a vessel and the orifice be stopped, after two hours the air in the vessel is so impure, that a candle placed in it will go out, and a little lime-water, shaken up with it, will become turbid from the CO_2 forming carbonate of lime with the lime. However, though CO_2 and H_2O are given off by the skin, still watery solutions do not penetrate it from the exterior, though greasy substances, if well rubbed in, reach the sebaceous and sweat glands, whence they get by the blood-vessels into the general system, and this process is quickest where the skin is thinnest, as under the armpits or in the groins.

Chapter XIII.

THE HEALING ART.

Not only are the prevention of disease and measures of hygiene very important, but no less so are skilful medical and surgical treatment, careful nursing and advice. The healing art has in recent times made rapid strides, and even in the last few years many most valuable discoveries have been promulgated, whereby our scientific resources are greatly increased.

According to Mr. Shirley Jones, the earliest existing work on medicine is that known as the Ebers Papyrus of the 16th century B.C. This consists of brief accounts of diseases of the abdomen. Herodotus says that the Egyptian physicians were allowed to practise only special branches, such as the eye, the teeth, diseases of the head, and so-called secret internal maladies. The Egyptians thought the use of herbs an essential aid to their magic. Their prescriptions mainly contained herbs, but inorganic compounds were also used. Hydrotherapy was not mentioned, but sun-baths and sand-baths were well known.

We have advanced far since the time of the Ebers Papyrus and that of Hippocrates, who performed such astonishing cures in the Isle of Cos, and knew full well the advantages of the fresh-air treatment; but in some respects we might do well to study their methods. The chief respect in which we have progressed is in our knowledge of the causation and diagnosis of diseases, but in treatment also on the whole great headway has been made. So great, indeed, has the advance been that diseases and derangements, which even some few years ago could not be controlled or even comprehended, can now be arrested by new methods of cure, when not actually preventable.

Timely relief of pain, or an alleviation of some slight disorder, perhaps imperceptible except to a physician, may obviate a long illness, avert intense suffering, and save life. The sufferer may think there is not much the matter, if only some slight inconvenience be felt; but in all such cases a careful examination should be made by an experienced practitioner, who will give the best advice. Often even thus a running down of the vital powers may not be very obvious, for it is quite possible to be greatly wanting in vigour, without much tangible sign being evident. At such times as these, or rather when in such a condition, persons may be very vulnerable to any infectious or other disease. Hence, when feeling run-down, it is always best to take measures at once. If there be delay, matters may be made worse, even without one realizing the fullness of the danger. One can become accustomed to ill-health, to lack of vigour—even to actual disease. The system

gets used to the adverse factors. One has only to note the difference in the complexion, to observe how vastly different is the intensity of the oxidation processes in the body. The pasty look that is apt to arise in the denizen of a closely-packed habitation illustrates the risk that comes from too near living together. Human beings are apt to infect one another when they become too gregarious, and they are really better off further apart. Plenty of freedom and fresh air are essential for vigour and even for health.

It is often very true in such a case that "a stitch in time saves nine." Should any organ exhibit signs of weakness or disorder, the most suitable measures should be taken without delay. In short, we recommend people not merely to consult their physician when they are ill, but periodically, and even if they be ostensibly as well as they can expect to be. The physician will detect danger, before it shows itself to the inexperienced eye. Hence a visit should be paid occasionally to a good practitioner, and, especially of course if there be any disorder, great care should be taken to carry out the measures for relief advised.

It is a great fallacy to suppose that old people must necessarily suffer pain and deviation from health. In the old, as in the young, symptoms of disorder should be taken carefully in hand, and no one ought to endure pain, without having recourse to the best advice and most suitable remedies which can be procured. Very many people shorten their lives by reason of neglect, and render their later years miserable, owing to the fact that they have not bestowed their attention on what seem to be merely minor ailments. For instance, morbid sleepiness and undue fatigue after only moderate exercise may be owing to something very wrong. Loss of flesh, too, may be not attended to, and yet it often is a sign of grave mischief. A great many people do not treat seemingly slight disorders seriously, thinking but lightly of them. In certain cases it may be want of money, in others a kind of parsimoniousness, in some carelessness, in others again incredulity respecting, or want of knowledge of, the many remedial measures which can be supplied. Whatever be the reason, it is an indubitable fact that a large number of people neglect colds, attacks of neuralgia, indigestion, palpitation, nervousness, rheumatism, gout, and so forth. They seem to look upon a yearly cold as an absolutely inevitable thing, and in general consider it just as well to let these and all minor maladies take their course unchecked, without making any decided effort to effect a cure.

Lives are often shortened by inattention to disorders, which are erroneously supposed to be of small importance. Similarly, many suffer their teeth to become decayed beyond control, before consulting the dentist. This neglect of ailments is liable to lead to great reverses, to families being left without their parents—hopeless and helpless. The earliest symptoms of disease should be regarded as the signals of danger. It is owing to neglect of the insidious onset of maladies that human beings are often cut off in their prime—even in the flower of their youth and strength. "You look very ill," may be said to such

a one. "Oh, it is nothing, it will soon pass off." "Sir, I would advise you to consult a wise physician." "Oh no, there is no need for alarm. It is merely a passing spasm, only a slight pain, or only a little palpitation, or giddiness, or depression of mind." Thus think numbers of human beings, and so they put off seeing a medical adviser, until the disease has gained a firmer hold, and can only be dislodged by dint of a great deal more skill and patient care than would have sufficed, if they had been wise and acted at once and nipped the evil in its bud. This is only one instance out of hundreds which might be adduced of the indisputable fact that many of us do not try to use the numerous valuable resources which are ready to our hands, if we would but stretch them out, in this age of skill and power.

Power of resistance to infection by disease, and indeed the general vigour of the constitution, depend greatly on the strength of the circulatory and respiratory functions. These depend on the due exercise of those functions by carrying out some form of healthful activity. Even when people are too weak to voluntarily use the ordinary muscles in exercise, something can be done in this way by carefully regulated chest exercises, whilst for those weaker still, passive movements and massage can be tried in many cases, but the latter must be well and carefully carried out, or far more harm than good may result.

One other point about healing is the influence of the healer's will over the mind of the patient. The latter may, through sheer lack of knowledge, feel so uncertain and dubious respecting his or her state and what can be done to improve it, and so dissatisfied with the progress made, that the mind, acting adversely on the body, retards all nature's efforts to cure. It is just in such cases as these, sometimes called neurasthenia, that the powerful mind of the capable and competent healer can do good. There is a great tendency in the human mind to be despondent and despair of a cure being performed—to think it nearly impossible that such should be the result of the measures taken. The clever healer knows what almost miraculous results can be obtained, and the confidence possessed must be instilled into the patient. The wisest speech is not: "This medicine or this measure may do you good," but it is better to say, "If you'll trust in me, I will direct you to do all that can and must cure you, and carry out my part to the full, provided only that you also will do yours."

Chapter XIV.

EDUCATION—EXAMINATIONS—MENTAL POWER.

Pupils, and especially young ones, should be thoroughly and not hurriedly taught. At first the teaching should be deliberate, not pressing, and the grounding in the rudiments should be good and sound, so far as it goes. Thorough elementary work should precede commercial and scientific training. Soon there will be a very great extension of our business transactions, as new places in the world are being opened out to our trade. For success in this matter, the practical bearings of the results of scientific research must be known and applied. On these results, too, depend our hopes of advance in command over the forces of nature.

The health of the body is most important, especially in the early years, and hence perhaps it is well that training should not be begun in a stringent way, until the child is about eight years of age. Then a systematically planned course may be commenced, and, so far as possible, this should be arranged in regard to a particular vocation. It is not only book-instruction which should be imparted, but also as a rule the arts of swimming, riding, rowing, cycling, type-writing, shorthand, fencing and self-defence, music, singing, and dancing.

The advantages of a thorough physical training of the body are becoming recognized. It is now generally agreed that nearly all boys and girls should be taught to swim. Moreover, drawing and painting may with great benefit be learnt.

The natural sciences, especially in so far as they are concerned with the welfare and care of the body, are most important. No doubt our educational system needs still to be reformed and modified in regard to the scope of subjects taught, though there has been of late years great advance in this respect. Immense progress has undoubtedly been made, and it is only seldom that one meets now, especially in the younger generation, with lack of power to read, write, and perform simple arithmetical calculations. Yet a want of knowledge of elementary scientific facts and principles is still very general. Information as to the necessaries for preserving health and strength should be ensured, and the subjects dealing with such points as are essential for the health of human beings should on no account be omitted. Some knowledge of biology is almost indispensable for understanding the due care of the body. That science includes the branches morphology and physiology, and an elementary acquaintance with both gives some power of comprehending the laws of health. These subjects unfortunately are the very ones which are most neglected

in preparatory institutions. As a rule they are completely ignored, and, even in more advanced colleges, there is frequently a decided preference for studies which do not directly bear upon vital processes. Such subjects need not be depreciated or omitted, even if some earnest attention were to be devoted to the most important of all studies—that of life. It is true that vital processes cannot be completely understood at present, and certainly not without also knowing something of chemical and physical science, but the general principles of physiology ought to be taught with a view to the acquisition of knowledge how to preserve the bodily health. To possess such information is most important.

In teaching, undue fatigue of mind should be avoided. The rooms for scholars should be kept clean, well ventilated, and open to the light. All public rooms, and especially school-rooms, should be kept free from infection, since, however careful parents, teachers, and the sanitary authorities may be, it will occasionally happen that children may attend whilst suffering from disease. Even after they have been known to be ill, they may commence re-attendance before being free from infection, and indeed they should not be admitted without a certificate of being safe. However, even that would not preclude all dangers to the other scholars, for cases arise where people carry infectious germs, without themselves suffering so as to be incapacitated, and even without being manifestly ill at all. As a routine precautionary measure, all public buildings, and especially school-rooms, both private and public, should be thoroughly cleansed and disinfected once weekly. Not only the health but also the lives of human beings are at stake. Good sanitary conditions of public assembly-rooms, in regard especially to ventilation, disinfection, and closets, are most essential. It is largely in public buildings that diseases are spread, and school-rooms, churches, chapels, and public halls especially need most careful management.

If one considers all the aspects of compulsory education, and especially the liability it has caused to increase the incidence of infectious disease, as has been considered probable by Sir Shirley Murphy, and is no doubt a fact, one cannot be so confident as some seem to be that it was an unmixed blessing to the nation. The fact is, like all other so-called and seeming improvements, the advantages connected with the system have been largely counterbalanced by grave disadvantages and dangers. Compulsion is often indeed very wrong, even when it at first sight most seems right.

Education should voluntarily be continued whilst life lasts. Improvement can go on in the later years, for it is never too late to learn, though the acquisitions to be gained must vary in nature according to the power. Grown-up persons can always take further steps in knowledge, and even if much has been forgotten, much can still be learnt. The fact of loss of activity need not debar one from advance in general information. Indeed, it may even, by paving the way for more leisure, facilitate the acquisition of abstruse subjects. The best

authors can be studied, and so far as practicable, one should aim to hear the finest orators and best vocalists and musicians.

In regard to the time for mental work, it is wisest to use as far as possible natural light, so as to avoid straining the eyes. Close mental or hard physical work should not be undertaken directly after any heavy meal, but an interval for digestion should be allowed.

So far as possible, and especially of course in regard to scientific subjects, the instruction should be of a practical kind. Not only is practical knowledge more useful, but it is also more easily learnt and remembered, because it is thereby far more vividly and usefully impressed upon the mind.

Practical tutorial or scholastic work in science is often a matter of great difficulty, partly because, to go far and deeply into it, would mean a large expenditure of time and money. However, what is true of all learning is also true of this part of it, viz., that a little well learnt is of far greater value than a great amount badly and imperfectly grasped. It is obviously impossible to know many subjects well, and it is best to get to the bottom of what one does attempt to learn. It is often very difficult to look beneath the surface views.

Mental Power and Examinations.

Antagonism is apparent in every department of nature, and the nervous system is no exception to the rule. The character of mental changes and states varies greatly from day to day.

Even where the necessity of teaching science has been fully recognized, the one most useful, physiology, has been ignored by many, who will continue to run in old ruts, adhering to established routine. Yet signs of progress are apparent, though they are but slow. In regard to all matters, and education especially, a stationary position is a quite impossible one. It is very important that teaching in physiology should be carried out. A civilized man differs from a savage mainly in having a more highly developed nervous system, and though the advance has not been without some bad results, still there is a generally higher intelligence to be observed in the former. Human beings differ most in this respect. For example, altruism is now recognized as of more importance as a guide to human conduct, whilst egoism is generally regarded as a sign of marked inferiority, and race-animosity is becoming less pronounced. The idea of self-preservation, when carried to an extreme, may become harmful.

The nervous system consists of cells and fibres. The former are chiefly arranged in groups, the chief of which are the brain, the spinal cord, and the solar plexus. The last of these is situated immediately behind the stomach, and it has much to do with the feeling of sinking of the stomach, and of satisfaction—caused by hunger, and by a meal respectively. The nervous system, no less than the other bodily organs, should be properly nourished, exercised, and rested. Mental infirmity has been said to have been on the increase of late, on account of the severe pressure of hard times and keen competition, and to some

extent this is probably true. Extreme anxiety is often caused by financial stress, and waves of such stress may result all over the world in consequence of severe wars, or a spirit of gambling. Money panics, however caused, may work incalculable harm.

If one should develop a marked and prolonged distaste for kinds of activity which have previously been a source of much delight, or there arise great irritability, with or without failure of memory and power of sustained interest or concentration, such warnings should be taken. Or if there be either sleeplessness, or only light restless slumber haunted by anxious dreams, reproducing perhaps more or less clearly the troubles of the working day, a complete change of scene and mode of life is necessary, and should be taken at once, before the prostration is too severe to be cured. Deep and prolonged anxiety, arduous study, excitement, emotion, or mental shock, may lead to brain trouble, evidenced by headache, loss of memory and sleeplessness as said above, illusions, bad and confused dreams, irascibility, peculiar feelings in the body or the fingers, twitchings of muscles, diminution of power gradually leading to paralysis in some part or parts. The paralysis may in certain cases even come on suddenly. In all such cases complete rest of brain is requisite, and every action demanding thought so far as possible given up. Indigestible food, spirits, wines, and tobacco must be refrained from; and the liver, bowels, skin, and kidneys should be induced to act well.

Moreover, insanity may be produced by too severe mental work, and it should be recognized that many people have to be content with about six, five, or even four, three, or two hours' close brain occupation daily. The excessive mental study pursued by some cannot but produce bad results. Cramming is most ruinous to the constitution. It is wrong from every point of view to overstrain the mental powers—even more dangerous indeed to do so, than it is to perform an unduly hard day's physical work. It is high time that some one should speak out against the terrific evils, the shatterings of constitutions of boys and of girls, which have resulted from one of the most disastrous customs of the present day, viz., cramming for examinations, which, especially when coupled as it usually is with long confinement in rooms insufficiently ventilated, is most pernicious. A clear head and common sense can at times be greatly aided by close and long application, and such is often necessary for examinees and professional men, such as doctors and lawyers, as well as other business men, for it is sometimes necessary to concentrate a lot of knowledge for a certain purpose, even though it may not be of much further use afterwards. As a rule, however, it is far the best to avoid cramming and diffuse application. One cannot think very highly of the character of much of the work produced by those evils of the day—examinations, necessary evils though in certain cases they may be thought by some to be.

The Chinese system of examinations has, we believe, retarded the progress of that intellectual race, and the same is doubtless also true of several other nations.

Chapter XV.

DEATH—PREMATURE BURIAL—SIGNS OF DEATH—DISPOSAL OF THE DEAD.

"Death," says Lavater, "does not only beautify our inanimate form, nay, the mere thought of death gives a more beautiful form to life itself." This optimistic view is very encouraging, especially when it is compared with the depressing observations of other writers. For example, Schopenhauer held that man's capacity for pain increases, as time passes, more markedly than his capacity for happiness, and that it is especially augmented by his foreknowledge of death.

The fear of death, which so constantly depresses many human beings, and is only held partly in check by the great difficulty often experienced by many in maintaining existence by earning a livelihood, is probably scarcely ever present in the great majority of animals. When analyzed, the fear may be resolved into two distinct apprehensions, viz.: (1) The fear of what will happen, or be done, to the body after the helplessness of insensibility has set in, and (2) The fear as to the future of the feeling of self-consciousness after vitality is extinct. It is partly, in fact, the fear of being helplessly cribbed, cabined and confined, while one's conscious will may still persist. The desire for movement may, it is surmised, be still retained, although the power has ceased. Recognizing such apprehensions in oneself, knowing these fears, one cannot but sympathize with them in others. This feeling of sympathy is one of the mental conditions mingled with other kinds in the passion of love, in which, however, many diverse impulses and emotions are combined.

Animals may shun and even fear death from instinct, but they have no real knowledge of it, and do not have the prospect of it constantly recurring to mind, as is so frequently the case with most human beings. On the other hand, the older the latter become, the more truly cognisant do they appear to be of the certainty of approaching dissolution. The desire for life becomes slowly developed, being dependent upon consciousness, and even though the faculties become dulled, and existence mainly a painful burden at the last, it may be gradually stronger as a rule up to a certain point before that stage be reached. Hence one may come to dislike the idea of death all the more strongly, in proportion as one realizes its inevitability and the great loss it involves. This is perhaps for many scarcely at all lessened by the promises of future bliss, which are apt to seem somewhat shadowy and even unrealizable, except by those whose minds have been cultivated in the direction of the highest spiritual ideals. Especially,

of course, is this the case when life seems pleasant and full of pleasurable activities. It is chiefly when the powers of the body and the mental faculties become dulled, when the hearing is less acute, the eyesight less keen, and the elasticity of movement has gone, never to return, when, in short, the mere fact of living is more or less a painful burden, that many have recourse to the solace of religion and the aspiration of immortality. Even then, feelings of returning vigour and exhilaration are apt to chase away the loss of hope.

> "The devil was ill, the devil a monk would be;
> The devil was well, the devil a monk was he!"

Love of life depends mainly on the realization of the consciousness of personality, and this, in the infant, is but slight, indeed almost non-existent at first. It slowly becomes more definitely conceived in the first months and years of life, and in the very aged, too, it wanes again a little towards the last, though as a rule human beings do not live long enough to get to this stage of second childhood. The consciousness of self is also sometimes lost in disease. For example, in the delirium of fever one may seem to be two persons in one. It is also much confused by the influence of some sedatives, narcotics, and stimulants, such as opium, belladonna, alcohol, Indian hemp, henbane, conium; and even tobacco imparts at times a mental haziness. Vertigo may be produced by dancing, swinging, and otherwise, and the clearness of self-consciousness may be partly lost, as it may be also in persons of unsound mind. These and allied mental phenomena complicate the question of immortality of the soul.

Not only is the fear of death almost universal in cultivated human beings, but also the positive love of life itself and the instinct of self-preservation are almost constant characteristics in living organisms. There are many kinds of insects which, when alarmed, become motionless and feign death, because their foes will not eat them, if supposed to be dead. This repugnance shown towards death is not possessed by rats, for these animals will eat their dead comrades, even when they have succumbed to plague, whereby they get the disease themselves. On the other hand, oxen and sheep exhibit terror and shrink, when confronted with dead bodies of their own species. Yet the knowledge of the inevitability of death is confined to human beings.

The fear of death is partly variable according to the individual's point of view, also to the state of health, being often more marked in the ailing or depressed; but it also varies in some degree in different nationalities, not being pronounced in savages, for instance. We learn, too, from Dr. A. Wiedemann, writing on "The Realms of the Egyptian Dead," that the thoughts of the Egyptians dwelt much and gladly on death, which had no particular terror for them, any more than it has for modern Orientals. They looked upon death not as a final end, but only as an interruption of their existence. The body of man was regarded as a battlefield, where good and evil spirits fought for the mastery. If a man was healthy, the good spirits were victorious,

and if he became sick, the evil ones. To drive away evil spirits, he must wear amulets, or repeat spells against them. These were the remedies for diseases, which were supposed to be the work of evil spirits, as above said, the medicines given at the same time only serving to reduce symptoms, and moreover these, it was thought, owed much of their virtue to spells repeated during their preparation. Any cure was put down to the conquest and departure of the demon who had entered into the man and caused his illness by spells and potent magic symbols. In the end the evil spirits always won a sort of victory, for one of the many male and female sicknesses at last destroyed the mortal frame. This death of the body was, however, only an incident in the struggle which lasted beyond the grave. Hostile spirits could prepare a second death of the immortal parts, and hence the Egyptians strove eagerly to find means, which would be efficacious beyond the grave to protect from foes, himself and his forefathers. Both in this world and the next the best safeguard was the knowledge of the appropriate spell. Egyptian religious literature consists largely of collections of such spells, which were sculptured on the walls of the grave or on the sides of the sarcophagus, or inscribed on papyrus rolls and placed with the dead in the tomb.

Young people, whose vigour seems to them at times almost illimitably great, often—one might almost say even generally—run great risk of losing their strength. On the good side boys display perhaps self-sacrificing heroism, and on the other a leaning towards several dangerous kinds of excess. This is doubtless partly and chiefly because the system seems quickly able to throw off the weakness and depression thereby occasioned. The old as a rule attach a higher value to life, and probably often feel more fear of death. Sometimes, it may be that, in the very aged, there may arise a feeling of desire for death, similar to that experienced for sleep after a hard day's work. This instinct is, however, exceedingly rare, and probably non-existent, if recovery of any marked degree of strength and health be deemed possible. When it does occur, death may often actually be attended by the just-mentioned sensations of a nature similar to those felt on falling asleep after a day's work. A kind of pleasant idea of emptiness or of absence of all feeling is often then experienced.

As each minute passes, about seventy human beings are born on the earth, and about sixty-seven die. There are said to be some 1100 kinds of ill-health; but all ordinary deaths are finally due to (1) Coma, due to loss of power of brain; (2) Asphyxia or suffocation, when the lungs are not oxygenated; (3) Syncope, when the heart fails. Deaths due to coma and to syncope are perhaps generally painless, though those from asphyxia are probably, at least at first, painful. Deaths due to very violent injury, which are generally nearly instantaneous, cannot be felt, for there is no time during which sensations can be perceived. It is, indeed, probable that in many deaths a kind of numbness of the sensory centres may be induced, or even an altered sensibility or sensation may be experienced.

At any rate Heim, a Swiss savant, says that tourists, who had sustained serious falls when mountaineering, and been cognizant of the premonitory symptoms of death, had felt them as a kind of ecstasy. Yet death may be either thus pleasant, or on the other hand more or less painful. Those who die from starvation do not experience painful pangs of hunger at the last, for the actual pains of hunger last only about twenty hours in man, being followed by a feeling of general weakness, emptiness, and of a lack of support to the heart, which for a time seems as if it were loose in the chest, although this sensation afterwards disappears. Moreover, the fear of death does not generally last until the end of life, being replaced by a longing to have done with the struggling to breathe. However, the pain of thirst is said to endure to the end, or near it.

It is to be remarked that death is not perhaps really inevitably necessary for all living organisms, and some authors, e.g., Naegeli, have even maintained that there is no such thing as natural death. So severe is the struggle for life, so voracious are the foes of organisms, amongst which may be included the pathogenic germs, so common are serious accidents, and drawbacks such as scarcity of water and the like, that most creatures are brought to their ends by some or other such means. Even when old people seem to have fallen quietly into dissolution, a post-mortem examination usually shows serious disorders of internal organs. Very few persons die as a result of mere old age, and many of those who live to be even above eighty succumb to diseases which might with greater care have been avoided or cured.

If natural death occurs, it is only in the very old, and even in them it is brought about by phagocytic destruction of the higher elements, and by various infectious and other diseases that affect the old, such as pneumonia and nephritis.

The murder of the aged is a widespread custom among the lower races of mankind. In some cases this may be partly because of the belief held by the greatest part of human beings, that this life is a stage leading to future existence, which, in the case of the good, will be a happy one, and in that of the bad an unpleasant one. This is really the basis of most religions. It is thought that the spirits of the dead persist, and those of ancestors are gradually thought of as gods, evil or beneficent, as they may have been in life. In order to understand the cruel custom of murdering the aged, it may be remarked that the aboriginal Fiji Islanders are firmly of opinion that they will be born again in another world in exactly the same condition they are in when they leave this one, and hence they like to die before becoming afflicted with any weakness. Consequently, when the approach of age is felt, the children are informed that the time for death has arrived, and, if this notice is not given by the ageing one, the children will take the initiative in the matter. A family council fixes the day, the grave is made ready, and the doomed one is allowed to choose between being strangled and buried alive. Similarly, among the Esquimaux, the priest-physician states when a person should be placed in a hole in the

ice, and left to die. This horrible cruelty is practised on the aged who are infirm and enfeebled. The Zulus, if a man be wounded in battle, kill him by cutting a blood-vessel, and if a man be lamed on the march, they let him choose betwixt being put to death, e.g., by drowning, or being left to perish of starvation. Indeed, probably many primitive peoples act in similar ways.

Ought we to put aside the thoughts respecting death which continually thrust themselves upon us ? At any rate, it is clear that we should not be always thinking of it, nor should we be afraid of meeting dissolution. There are worse things in life. Soldiers do not usually think of death whilst in action, and those who are naturally timid try not to think of it. The anticipation is probably worse than the reality, as in most other things that we naturally shun. A human being, who is conscious of approaching death, can still never realize it, and does not know the moment life ceases. After a long and trying fever the idea of what seems like nonentity is rather longed for with intense desire, so that one may be relieved from endurance of the pain and burden of life. Persons in full possession of their faculties who are momentarily expecting the inevitable plunge into the unknown abyss of non-existence may wonder,—" Are we no more than poor weak machines, mere sputtering candles, with no end and aim, guided by nothing but blind forces, or is there some great controlling Power which watches over us ? "

What are we to think, too, concerning the idea of the immortality of the soul, above referred to as being rendered more complex by the phenomena of insanity ? The belief that after death comes another kind of life, acts as a beneficent solace and comfort for the anguished minds of human beings, when deprived of loved ones who have left the earth for ever. The hope, which to many is a conviction, that some time they will meet again is undoubtedly very helpful. If it is pointed out that there are powerful arguments which can be alleged against such a belief, it seems to be like taking away a great help in bearing the sorrows of this existence. Yet to others proof seems requisite, and the questionable logic of a too ready credulity may actually excite disbelief in an idea, which it has recently been attempted to place on a scientific basis.

How strange is the relation of all things to each person, of each person to all things ! We can scarcely imagine the state of mind of one who knows that death is near, especially if the power of connected thought is fully retained, as sometimes, and not infrequently, is the case. A dying human being can do no other than vaguely acquiesce in something in its very essence inscrutable. This submission is at the last thrust upon each living being, who has time and the power to think, as the end is known to be near at hand, and the resignation is aided by the realization, that it is not possible that there can be a sudden transition from a state of complex existence full of all kinds of possibilities, to one of complete cessation of consciousness, in which we are merely lifeless lumps of flesh soon about to decay. We cannot

conceive this to be true even of animals, and far less of human beings ; but must postulate that there is some kind of continuation, though we know not of what nature it be. Clearly the poor bodies left should be treated gently, and with respect.

Socrates said he did not fear to die, because he felt confident that something of this life remains, and that the good will be treated better than the bad. Other philosophers counselled resignation, coupled with the hope of a return to some universal and eternal principle after death. Plato believed in the immortality of the soul, and in the transmigration of souls, but did not accept the idea of resurrection of the body. Spinoza held that the human spirit could not be absolutely destroyed with the body, but left some eternal remnant, and that at death there was a return to the immortal and universal substance.

Schopenhauer held that consciousness ceases at death, but that the cause which produced the consciousness still persists, the ultimate principle of life apart from consciousness, which became a human being, remaining existent eternally ; also that life is a series of misfortunes, and the cessation of a well-regulated life should be calm, pleasing, and peaceful ; also that in resignation to, and even in a desire for, annihilation, is to be found the best consolation. Hartmann even went so far as to hold that love causes far more suffering than pleasure to the lovers. Guyan refers to separate consciousnesses becoming, so to speak, mingled, without their individuality being lost by the union, and he says that resignation is best, probably meaning resignation to the prospect of annihilation, which is also counselled by many other philosophers. Though, however, this be the outcome of deep thought, still it is no less true that the general feeling of mankind is frankly and thoroughly optimistic, for one has only to look around on, say, a Bank Holiday crowd, to realize that in very many human beings an intense pleasure is felt in life, especially if it be healthy and strong. It is rather in the highest stages of mental development that one recognizes the futility of human endeavours and hopes, though this may probably not be always the case ; for it may be possible to suppose that very wonderful discoveries of the real meaning of human life may ere long be made—discoveries which may alter many modern views.

Premature Burial.

Live sepulture, which is a barbarous custom of some low and occasionally of some relatively high peoples, has been prevalent on the face of the earth ever since the dawn of human life. No greater terrible cruelty than has been, and is, practised by man on man, is known throughout the vast domain of Nature. Not only do the Fijians constantly carry out live burial, but even so highly civilized races as the Hindoos and Chinese occasionally practise it. Indeed, we have no superiority to boast of, in regard to sheer diabolical cruelty and culpable carelessness, for in the Middle Ages human beings were sometimes bricked up. Live burial is not now done knowingly,

but there is no doubt that, so far from being on the wane, it is frequently inadvertently carried out, owing to carelessness and want of knowledge of scientific facts regarding trance, and allied states of suspension of sensibility without loss of vitality. A human being may appear to be dead, and yet retain life in a latent and quiescent form. No more horrible form of disposal of the dead than the one now prevalent is recorded in the history of mankind. The Chinese carry out superficial burial, as do several other nations, including the Malays, and as did also to some extent the ancient Egyptians. This custom is preferable even on sanitary grounds, though it may give rise to offensive juices and odours rising to the surface. Probably thousands have been buried alive in this and other European countries, and especially in such countries as Africa and Australia, where bodies are so quickly taken to their last resting-place, no doubt mainly on sanitary grounds. From a letter of H. W. Denton Ingham, Secretary of the London Association for the Prevention of Premature Burial, we learn that cases of premature burial derived from medical sources alone number 149, and narrow escapes from such a disastrous calamity number 219. It is customary for some to disregard this danger, and to maintain that the risk is an infinitesimal one; but, even if this were indeed true, and it is probably just the reverse, it is, nevertheless, one of the most terrible possibilities that any human being may have to encounter, and no ordinary form of suffering can be compared with it. We suspect, too, that the fear of it has in some cases led the unwise and depressed to commit suicide. One of the chief reasons why the matter is so put aside is because it is thought, on hygienic principles, that the keeping of the dead entails great danger to the living. No doubt there is some validity in this argument; but still, however short a time a body be kept, even if only three days or in some cases a shorter time, there is not the least cogent reason why any such awful risk should be run as the waking up to conscious life in the coffin.

Most people would agree that it would be far better never to have been born than to be buried alive, and even if one only survived for a few seconds, the horror which would be experienced during those seconds is quite indescribable. It is difficult to imagine any more awful form of suffering, and one can only marvel at the apathy prevalent in regard to this possibility. The only explanation of the indifference of many is that the struggle for life is so keen, that one's whole mental faculties are apt to be engrossed in it. However, now that public feeling is being aroused, it is quite probable that ere long the reforms so greatly desirable may be inaugurated. In the meantime each person should take the necessary steps of precautionary measures, so far as possible, and entreat those with whom they live to make sure of death before burial.

Many devices have been suggested to prevent the chance of premature burial, and most of these are unsatisfactory, including that of being able to move a signal, or ring an alarm bell, after being actually buried, a means of doing so being placed in, or close to, the hand.

Cremation, embalming, and all other allied methods only substitute a perhaps slightly less horrible mode of dissolution, if the person be not really dead. The same objection holds with regard to autopsies, though in this country at the present time, under the conditions now existing, perhaps the most sure way to absolutely prevent live burial is to take steps to ensure that a post-mortem examination be made by a surgeon before burial. Lady Burton directed that a large needle should be made to pierce the heart, and that the body was to be embalmed, after such procedure should have proved that life was extinct. Miss Frances Cobb directed that the carotid arteries, with, we think, also the windpipe, should be severed. At least some such procedure was enjoined in her and in other cases. Others have directed that the heart be removed, and some that the cervical vessels and soft structures of the neck be severed in whole or in part, and some that the head should be cut off from the trunk. Some have said that a needle should be used to pierce an eye, or the skin ; but these tests would not exclude some forms of trance. On the whole, perhaps the complete severing of the head from the trunk would be the best preventive of live sepulture, bodies being decapitated before the lid is screwed down.

Most precautions against the possibility of premature burial are open to the objection that it is difficult to feel sure they will be carried out, for, firstly, they may be opposed to feelings of false sentiment on the part of relatives, and not only are they unprofessional procedures on the part of a surgeon or undertaker, but are also liable to give rise to the suspicion of foul play, and are indeed possibly offences in point of law. The only way, therefore, that is in present times feasible is to enjoin and take measures to ensure that a post-mortem examination be carried out by a surgeon. This being a purely professional course often adopted, less objection and less opposition is likely to be encountered from relatives and friends on sentimental or other grounds. It would be well if there were in all towns a properly constructed mortuary for this purpose, and a surgeon whose special business it should be to carry out the work, and it would be better if he were well paid, and therefore able to abstain from—at any rate general—practice.

Another valuable note in this connection, i.e., with reference to decapitation of the dead, above mentioned, we cull here from Dr. A. Wiedemann's work :—

" This belief in the mutilation of the corpse of Osiris seems to have been strongest in early times in Egypt, for it could be brought into connection with the dismembering of the human corpse which was then customary. It was divided into a varying number of pieces, but the severance of the head from the rest of the corpse was considered specially important. The pieces were buried in the cultivated land, probably near to the former dwelling of the deceased. After a time, when the flesh had decayed, they dug up the bones, collected and cleaned them, and buried them in their final tomb in the sand of the desert at the edge of the Nile Valley.

"Even in the age of the pyramid builders, this custom had become less common, though it was not entirely forgotten in much later times. Religious formulæ in funerary texts are based on the belief that the severed head will be restored to the dead man in the next world. Occasionally the custom was actually practised even in comparatively late periods. Bodies have been found which were first beheaded; then the rest of the body was embalmed, the head fastened to the neck with a stick, and the whole swathed in mummy cloths. In the pyramid age the entire body was sometimes treated in similar fashion. It was allowed to decay, the different bones were collected, each was wrapped separately in linen, and the linen-covered packets were placed together in the order corresponding to the position of the bones in the human skeleton.

"The dismembering and reconstruction of the corpse was not, in later times at least, the result merely of a wish to facilitate the dead man's passage into the other world: side by side with that intention ran in all likelihood the hope of throwing obstacles in the way of his return into this world. In common with other peoples, the ancient Egyptians regarded the dead as being bereft of all the joy of existence, and for the most part malicious beings who, filled with envy, must needs long to vex and distress their survivors. The more carefully the rites of burial were carried out, the sooner might the departed souls be appeased; to satisfy them fully was difficult, if not impossible. It was therefore important to resort to the same expedients which have been employed by the peoples of many lands to protect themselves against the dead who might return as vampires, e.g., cutting off the head of the corpse. Where the human body is considered the only possible form for the dead to take, this remedy might be regarded as infallible, but this was not the case in the Nile Valley, where the dead man returning to earth did not need to enter his own body again, but might choose from many other forms at his disposal. There was danger of his doing so, if he observed the mutilation of his body, and wished to punish the perpetrators of the deed. This must have been the consideration that led the Egyptians to reconstruct the body after dismembering it. If the dead man came to his grave to see that all was right, and the corpse seemed in outward appearance in perfect condition, he was satisfied. If, in an unhappy moment, it occurred to him to re-enter it, the body fell to pieces, or lost the head, and his hope of regaining his former shape was annihilated. Such thoughts certainly assume a remarkable absence of insight on the part of the dead man. But that again is a conception common to almost all nations. Death and the devil and the spirits belonging to their circle are commonly represented as stupid and easily deceived. Countless examples of this are to be found, not only in the tales of the ancient and modern East: in the folk-lore of northern nations there is rich and varied illustration of the same ideas."

We do not state that the Egyptians dismembered their dead partly in order to prevent the possibility of premature burial, but it may be

surmised that this idea might have been present in their minds, and a contributing factor of consideration.

The appointment of a surgeon in each town to perform autopsies would be at least a step in the right direction, which should lead to, or better be at once combined with, the establishment of "waiting-mortuaries." It would, indeed, be well also to enact that no bodies should be buried without either a post-mortem examination, or, in case of objection to this being raised, before palpable signs of decomposition were present on the abdomen (generally apparent first on the lower part thereof); but in many cases, especially in the winter, this would involve keeping the bodies for a long time, and some are so well preserved that it would scarcely be possible to wait for this commencing putrefaction. For facts in the next paragraph the author is indebted to an article by Mr. Basil Tozer in the *Nineteenth Century* for October, 1907 :—

Nearly 400 years B.C. Plato ordered that the bodies of the dead should not be buried until the third day after their supposed death. Some centuries later Pliny referred to the apparently dead coming to life. Again, Celsus asked, "How is it that some have returned to life at the time of their funerals?" The ancient Egyptians watched the bodies of the dead for many days, and often also decapitated them before embalming them, and the ancient Greeks, before cremating, tested the bodies by cutting off a finger. The Romans kept the supposed dead for a week before burying or cremating them. Generally, also, they placed them in hot baths, or washed them with nearly boiling water, so that if possible they might be reanimated. Servius, in his commentary on Virgil, says that on the eighth day they burned the body, and on the ninth put the ashes that were left in the grave. Quintilian also remarked that the Romans delayed burial because persons had been seen to return to animation as they were about to be laid in the grave. Moreover, Lancisi, in the 15th chapter of the first book "De Subita Morte," says that the law has wisely forbidden the too speedy interment of all dead persons, and especially of such as have appeared to die suddenly. It is clear from the above that the Romans were fully aware of the terrible liability to premature burial owing to the difficulty of being sure that death has really occurred, and it is really strange how we Britons seem to have almost entirely disregarded this necessity of being sure. Other ancient customs, e.g., that of habitual bathing, which was so well carried out by the Romans, were forgotten or neglected by the inhabitants of the British Isles for a long period, except among special classes, and certain forms of bathing, such as that of the so-called Turkish bath, have only in comparatively recent times been re-introduced into favour. It may even be doubted if even now the Turkish bath is constructed quite as well, except in certain special cases, as it was among the Romans. No doubt our half-savage ancestors learnt much from the Romans, and might have learnt much more, if they had tried to overcome the foolishness of ignorance. Returning to our topic, and coming to modern authorities, we note that Huxley

held it to be very difficult to decide on the indisputable signs of death, and Dr. Gowers wrote that persons have certainly been buried in a state of suspended animation. Dr. T. M. Madden held that neither the frequent occurrence of death-trance, nor the fearful results of its non-recognition, can be questioned. It was, indeed, officially stated some twenty years ago that one came to life out of every 300 bodies in the French mortuaries. Dr. Thouret, who was present at the destruction of the famous vaults of Les Innocents, informed M. Desgenettes that many of the skeletons were seen to be so situated as to indicate that the bodies must have turned in their coffins, and Kempner gives similar particulars of disinterments in New York and other parts of the United States, as well as in Holland and elsewhere. Moreover, Dr. Franz Hartmann has collected particulars of some 700 cases of premature burial and of narrow escapes from it. Again, on p. 1104 of *The Lancet*, of June 14th, 1884, is a letter in which the writer describes the terrible look of two bodies which he saw in the crypt of the Cathedral at Bordeaux, when part of the cemetery had been dug up.

There are, indeed, many conditions of a living body which closely simulate death. In many—probably the majority—of these a very careful examination by a clever and competent medical man would be sufficient to prove the possession of vitality, but it is quite possible that a merely ordinary examination would not settle the question.

Signs of Death.

Conditions resembling death are temporary syncope, asphyxia, and trance. The following signs should be considered, but it should be borne in mind that most tests of death employed are not very satisfactory or convincing.

1. Watching the seeming process of death, and noting the last gasps, the flickering pulse-beats towards the close, and the final cessation of breathing and contractions of the heart.

If one observes a dying person, in many cases it is very much like seeing a lamp go out, when the wick is turned down low. The respirations gradually become slower and slower, as well as less deep, and at last the only ones are gasps recurring at long intervals. Sometimes when the very last one seems to have been given, it will be followed by a few still more ineffectual efforts. Then the eyes, which have probably, already some time before death, become glazy, turn upwards in their sockets, as they also do in sleeping, and the jaw drops. This dropping of the jaw may be partly due to the effort made to breathe, partly due to its weight, and the fact that in health it is held up by contraction of muscles. When once dropped, the rigor, which comes on in the muscles, keeps it thus fixed. The attendant ties up the jaw, and places coins on the lids to keep the eyes closed. If this be done early, the rigor, which afterwards may probably occur, keeps the muscles in the position desired. When such phenomena and processes have been witnessed, and the gasps of breath have been noticed to become gradually less powerful, and to occur at longer

intervals, until they at last entirely cease, there cannot be much doubt as to the rcality of dcath, especially if it has been decided that there has bcen some disease or disorder sufficient to cause death. One may, then, infer that life has rcally ccased. However, this gradual diminution of breathing may not always be seen, and it is only, as a rule, in some form of lung-trouble such as bronchitis, that it is so markedly eonspicuous. In some forms of death the gradual loss of respiration-power is not shown, and henee, for one reason or another, for instance not being present at the death, or the process not being manifested, it is but seldom that one can aetually perceivc sueh gradual eessation of breathing. One has more often to decide the question if death has taken plaee or not, without actually seeing its occurrenee. For example, one may be sent for about midnight, perhaps on a snowy night in winter, and hcar that a man has gone to bed, apparently quite well, has slept, perhaps, a little, gurgled in his throat, and on the lights being turned up, been perceived to be apparently dead. In one sueh ease a man had eaten a hearty supper, gone to bed with bedroom window closed, probably slept heavily on the left sidc, with an engorged stomach bearing weightily on a heart already feeble, and rendered more so by a hard day's work, and possibly a too big dosc of antipyrin taken for a headaehe. The coldness of the night, added to the various other factors, no doubt facilitated the speedy elose to life.

It has been said that if respiration-movements have entirely ceased for five minutes, life must be extinct, but this is really not the casc. In order to test the absence of breathing, a bright eold mirror is held before the mouth. If there be any breathing, there will be some dimming of the bright surface, owing to the aqueous vapour eontained in the breath. A piece of eotton-wool held over the mouth would be stirred. Both these tests are of small value, and may mislead. Thc beats of the heart should be listened for with a stethoscope.

If an incision be made so that a vein be opened, blood will flow, if the circulation is going on. Also a ligature, placed round a limb or even a finger or toe, will cause a swelling, on aceount of the return of venous blood to the heart being thereby arrested. If the tying be tight, the part bcyond the knot may swell. However, in neither of thesc eases would the test suffice, if the heart had stopped beating. In that case there would be practieally no oozing of blood and no swelling, and probably no cut would be felt in tranec, or, if felt, it would most likely evoke no manifestation. As a ruie during life the heart-sounds and those of respiration can be heard, though in trance both may be very greatly muffled and obseure. In partial drowning and in other eonditions, probably both may be absent, though there be a possibility of thc powers tcmporarily lost bcing regaincd by means of artifieial respiration. Thc late Colonel E. P. Vollum, M.D., who himself was once ncarly buricd alivc, held that stoppage of thc heart's beats and arrest of rcspiration for a considcrablc time, couplcd with othcr apparcnt signs of dcath, except

decomposition of vital organs, do not make it certain that a person is really dead.

Moreover, it is not infrequently the case that, long after seeming death, vital processes may be exhibited by some of the tissues and perhaps organs, the co-ordination of vitality being absent. For example, when death has resulted from certain causes, e.g., some infectious diseases, the human heart may be removed from the body even more than thirty hours after death, and if treated in a particular way, it may go on beating for several hours. Further, the colourless blood-cells, the spermatozoa, and the cilia of ciliated cells retain power of movement. Likewise the heart in fish and amphibia will generally pulsate for some time after the animal is dead—even if entirely cut away and removed from the body. Indeed, contractility of muscles and irritability of nerves persists for a longer or shorter period, according as the conditions are favourable or the reverse. Death of tissues is therefore seen to be a gradual process.

A point which arises in this connection is the query, At what particular time can a body be said to be dead ? and there cannot be any doubt that it is, except in the case of a serious accident or a lesion of a very fatal nature, nearly always a gradual process. Indeed, Hufeland holds that death does not come suddenly, but as a rule it is a gradual process from actual life to apparent death, and from that to actual death.

2. Trying if sensibility be present in the seemingly dead, as by touching the cornea of the eye with the finger, or a piece of stick, the dead end of a match, a pencil, a pen, or a pin.

The most obvious sign of vitality is movement, and hence if an animal or man be quiet and motionless, one may suspect that something is wrong. If life be present, stimuli will nearly always be responded to in some way, or more probably in several. Touching a living animal, especially if any hurting be occasioned, will produce a sudden moving away of the whole creature, or if this be not possible, of the part being irritated or injured. The well-known facts that a frog, even one devoid of cerebral hemispheres, will quickly remove a toe if dipped in acid, and also that the anæsthetist touches the cornea of the eye to see if sensibility be retained, are examples of the certainty of reflex actions being performed, unless there be very profound disturbance of the system. The eye is very sensitive, and a source of injury or even a slight touch to the normal cornea, at once causes the eyeball to be moved and the lids to be contracted, so as, if possible, to protect the delicate structures from injury. Hence the unconsciousness is complete when no response occurs, and yet latent vitality is present in anæsthetic states of the system induced by drugs such as chloroform, ether, nitrous oxide, ethyl chloride, cocaine, eucaine, novocaine, or tropacocaine, although no movement is produced in eye or eyelid in response to the irritation of contact.

In the condition of hypnotic trance the eyelids often flicker, but this is an involuntary action, and not specially excited or apparently much augmented by touching the eyeball.

3. Cooling of the body. Although the time taken to cool varies in accordance with the external temperature and several other conditions, as a rule a dead body is quite cold in about sixteen hours after death. A fat body will cool more slowly than a thin one. A body wrapped in woollen coverings, or one kept in a warm atmosphere, will cool more slowly than one uncovered or in a colder air, also more slowly in air than in water at the same temperature. When there has been hyperpyrexia in a living body, the temperature may continue to rise after death.

4. To see if there be loss of transparency. This is one of the most unreliable signs. It has been said that if, when the hand of a body be held in front of, and close to, a strong light, with the fingers extended and close to one another, a line of scarlet is seen running round the fingers, that person is alive. However, Dr. Gannal, in "Signes de la Mort," states that the presence or loss of transparency is an uncertain sign, for it may occasionally be lost some time before death, and it is sometimes present in a corpse, and may be absent in sick persons who presumably may perhaps recover. Also Orfila says that the fingers of corpses, if placed between the eye and a flame, are seen to be transparent. Probably this transparency varies according to the conditions of the particular case.

5. The lustre of the eyes is soon lost. The cornea feels loose. The glazing and looseness may even occur before death.

6. To see if there be cadaveric rigidity due to rigor mortis. This test is not always a very satisfactory one, though if there be marked rigidity, death may generally be inferred. After death muscles pass through three stages.

(*a*). A state of flaccidity in which they contract if electrically stimulated. If the muscles were contracted at the time of death, they may not thus become flaccid, but remain contracted.

(*b*). Rigor mortis. This is due to coagulation of the muscle-plasma, whereby both irritability and transparence are quite lost. It may, however, occur without death in certain conditions, e.g., tetanus, though no doubt it usually leads on to death. On the other hand there may be some rigor without death, and bodies which have been nearly drowned and have had dropped jaw, due to rigor, and other muscles rigid, have been brought back to life. Again, rigor may be absent in a corpse even after some time, if the temperature be high, and probably if the tissues have been well alkalinized before death. Thus it seldom occurs in hot countries and weather, and on the other hand does supervene, to some extent, in certain diseased conditions during life.

Rigor generally sets in within about seven hours after death, and lasts usually one day, but may last seven days. It commences in the muscles of the neck and lower jaw, and goes to those of the upper limbs, chest, and lower limbs, passing off in the same order. The muscle-plasma coagulates, forming myosin, carbonic acid gas being given off, and the reaction is therefore acid, instead of alkaline. When there has been

very great muscular exertion, rigor both ensues and vanishes rapidly.

(*c*). The final stage is that of relaxation and incipient putrefaction.

7. The skin loses elasticity, and becomes pallid, except in dependent parts, where it is blood-stained, owing to downward gravitation of the blood. This, which is called hypostasis, occurs about ten hours after death. Ecchymosis is different, being actual extravasation of blood into the subcutaneous tissue, and amounting to more than mere staining.

8. It simply comes to this, that the only sure and satisfactory proof of death is the decomposition of vital organs. When putrefaction has begun, the limbs become supple again, i.e., freely movable, all rigidity having disappeared. A smell, which is at first only faint, becomes perceptible. The chief and most important sign is a greenish hue seen on the abdomen, and afterwards on the chest, face, arms, and legs. This process of putrefaction is delayed when arsenic or mercury has been taken, when embalming or other preservative process has been carried out, when adipocere is formed, or when the weather is very cold.

Dr. Franz Hartmann, of Hallein, in Austria, holds there can be no assurance that, in the apparently dead, the soul has departed from the body, so long, that is, as the only reliable sign of death, viz., the decomposition of vital organs, has not begun. To this remark it should be noted that even decomposition, as in the case of gangrene, may have advanced to a considerable extent without any very marked sign of closely impending death, at least in the case of a leg. A human being may live some weeks with a foully gangrenous leg; but the blackish green colour, which may come in a corpse on the lower part of the abdomen, may be taken as a fairly indisputable proof of death.

The danger of premature interment is far greater in tropical than in temperate climes. It is because of the rapidity of decomposition that bodies in hot countries and hot weather are so quickly buried. Of course, if putrefaction has begun, death may usually be inferred to be certain; but it is to be doubted if this sign is always waited for, when it is hot. Moreover, in temperate and cold regions and weather, putrefaction may be long delayed, and few would keep bodies for a sufficiently long period for this to occur. Hence some other test is often, and indeed usually, requisite, especially in certain cases such as those who have led a very clean life, and been struck down by some perhaps suddenly occurring lesion, or when the patient has taken certain drugs such as mercury or arsenic, above mentioned, or eaten much salt, all of which may preserve the tissues, and prevent or arrest putrefaction in greater or less degree.

Moreover, reliable signs of death cannot be obtained from the posture of the body nor the position of the hands and fingers, nor from the absence of fine crepitation sounds when the palp of the finger of a dead person is placed in the ear of the observer. Again, arrest of the retinal circulation, and the disappearance of the optic papilla,

are not conclusive signs of death. Breaking of the eyeball is not seen until death has been present for several hours, whilst the signs of ocular putrefaction are equally late. When a dead body is screened, the outlines of the intestines are clearly visible under the rays, on account of sulphureous gases distending the bowel, but this sign is also seen when the body is alive.

Dr. Eugene Stockis relies chiefly on Icard's "lung test," which consists in putting down into the larynx a piece of blotting-paper dipped in solution of acetate of lead. If sulphuretted hydrogen be present, the paper turns brown. This test acts within twenty-seven hours of death, and is the best for detection of early putrefaction. Lechamarzo found the paper browned, after for forty-eight hours being present in the pharynx of a patient suffering from extensive cancerous ulceration there; but this is not very likely to mislead.

Cessation of respiration cannot be proved by the candle, mirror, and water tests. They failed in several cases of syncope, and post-mortem gases may cause a flicker of the candle, an obscuring of the mirror, or a rippling of the water-surface.

Equally unreliable are the tests to show circulatory failure. The heart may resume its beat after a much longer period of cessation than five minutes, especially in newly-born infants. Cardio-puncture and cardiometry and stoppage of the pulse are untrustworthy as proofs.

Vergne's test (measuring the volume of the carotid arteries), and Laborde's (delay of oxidation of a steel needle inserted in the deltoid, muscle) are of no use. Loss of transparency is seen in young subjects in the fingers and ears, as well as in those of the dead. Icard injects fluorescin solution, but his iodide of sodium test is not so reliable. Ascarelli's test, showing acid reaction of the viscera, cannot be relied on. The liver or spleen must be punctured, and it is difficult or impossible to eliminate the blood. Cadaveric lividity and post-mortem staining are good signs. Devergie's sign of patches of desiccation on the skin are rarely apparent before the sixteenth hour after death. Explosible blebs are seen in syncope. Halluin drops a $\frac{1}{20}$ per cent solution of dionine into the conjunctival sac, and reddening or lachrymation will occur, even if there be grave syncope.

There are, it was said by Mr. J. B. Little, more than 120 Acts of Parliament relating in whole or in part to burial. These acts should be revised and co-ordinated, and additional regulations made concerning the ascertaining if bodies be really dead. A proposed Bill for the Prevention of Premature Burial (1907) provided that nobody should be buried without a medical certificate of death given after a personal inspection of the body, and stating the signs from which death is inferred, and death verifiers might be appointed. Justices might, by it, order the exhumation of a body buried without a death-certificate. More important still, sanitary authorities might provide "waiting-mortuaries," where bodies may be kept until death is certain.

The employment of "waiting-mortuaries" would certainly reduce the risk of premature burial to a minimum. It has been said that

one of these was first opened in Weimar in 1791, and that there are ten in Munich, others at Frankfort, Stuttgart, Wurtemberg, and Vienna. The seemingly dead bodies are said to be taken to the mortuary, and laid on tables in rooms well warmed, ventilated, and lighted. As yet the writer has not been able to see any such mortuary, and he was told, when in Berlin, that no such place was known to be at present used there. The late Sir B. W. Richardson held that the temperature should be about 84° F., and the atmosphere slightly moist, in order to favour decomposition, and thus prove death.

The bodies are supposed to remain in the "waiting-mortuary" from forty-eight to seventy-two hours, unless signs of decomposition occur earlier, or the patient have suffered from infectious disease, in which case earlier burial, or special precautions to prevent spread of infection, are carried out. In other cases extension of time may be allowed if desired. Cords going to an alarm bell are tied to the fingers of the seeming corpse. At Würtemberg it is said to have been enacted that "No body must be interfered with before the arrival of the inspector, who is expected to pay several visits before giving the death-certificate, which only he can do." In Gaubert's "Les Chambres Mortuaires d'Attente," it is said, "We have collected in Germany fourteen cases of apparent death followed by return to life in mortuaries."

To sum up (1) We can only say that a person appears to be dead, i.e., unless decomposition of vital organs has commenced. This is the only true sign of death. (2) Many persons have been buried alive. (3) Many will be, unless there be radical reform in our methods. (4) Sudden death occurs only rarely, except in cases of accident, or injury, or severe lesion. (5) Fits of trance, catalepsy, epilepsy, may show suspended animation, and sometimes the victim may be unconscious, but sometimes conscious of sight and hearing, though unable to move, the capacity for doing so being temporarily in abeyance. A body may wake up to full power after interment.

The author heard from a man still living that he had been laid out for burial, but fortunately he regained consciousness before things had gone too far. He has seen two men in a state of hypnotic trance, who looked very like corpses, and certainly might have been unwittingly buried, had unwary and ignorant people had to deal with them. In these and other like cases the heart-sounds and those of respiration were detectable enough, though muffled and obscure, and the pulse, too, could easily be felt. There was no visible corneal reflex in either case, and no additional movement when the finger was placed on the cornea, nor was there any other obvious sensibility to ordinary stimuli. The pulse was fairly normal and regular, and in one case the temperature was slightly (a little more than 1°) subnormal. Both cases were fed by rectal injections at intervals. Further is to be noted a description by Dr. W. T. Gardner in *The Lancet* of December 22, 1883, of a case of trance lasting for a period of twenty-three weeks.

Disposal of the Dead.

The Syrcanians gave the dead to wild dogs. Similarly the Kamschatdales keep special dogs for this purpose. Some Kaffir tribes take the dead bodies to the bush, leaving them for wild animals, and some ancient Asiatics did the same. The Scythians sewed up dead bodies inside the skins of animals, and tied them to branches of trees. Some of the North American tribes fold the corpse in a buffalo hide, and place it on a platform on the top of high poles. A similar custom is that of the natives of some parts of Australia, who cover the body with leaves and grapes, and either lift it into the fork of a tree and bind it to the boughs, or elevate it on poles. The Parsees exposed dead bodies on high gratings, for the purpose of being devoured by vultures. In some parts of India the bodies are carried to the top of a hill and placed on a stone slab, the bones being afterwards removed. The ancient inhabitants of the banks of the Persian Gulf threw bodies into the sea. Some American aborigines place the body in a canoe, and launch the latter into a stream or lake. Both burial and cremation were carried out in the earliest times, and are still by modern savages in North America, Australia, and the Isles of the Pacific. Savages cover the corpse with branches of trees, earth, or stones. Gorillas similarly place boughs and withered wood upon the carcase. Monkeys are said to use much solicitude in regard to their dead.

In modern times the disposal of the dead becomes one of increasingly greater importance. As is well known, the carcases of men and horses on battlefields may bring epidemics of diarrhœa, dysentery, and other diseases. Similarly, the emanations given off from thickly filled cemeteries are apt to cause ill-health, sometimes ending in death. Hence the topic should be very seriously considered, for a better way than the modern mode of burial may be suggested. Indeed, some improvement is being inaugurated, and burial in churchyards is not now usually allowed, save in country places. Every day on an average about 1500 deaths occur in England and Wales, making a yearly number of 547,500 bodies. About an acre of land is required for a population of 4,000 for a period of fourteen years.

Seymour Hale has shown that if carcases are covered by a foot of suitable earth, in one year the perishable parts disappear inoffensively, but legal regulations prohibit such shallow burial, by providing that all parts of coffins shall be so buried as to be at least 4 feet below the ground level. The nitrifying organisms, which are only present in the upper layer, cannot therefore perform their beneficent action. However, on the other hand, this rule usually prevents the germs and fœtid organic matter, and the ammonia, sulphide of ammonium, and sulphuretted hydrogen coming to the surface. Such gases may sometimes rise to the air, and they may pass laterally underground either to sources of water, or even in some cases to the foundations of houses. However, deep burial does not prevent the possibility of contamination of water supplies, though it possibly may somewhat diminish that risk. It is to be noted in this connection that nearly

all primitive peoples adopt shallow burial, and some scarcely trouble to bury, but, as above said, throw the body in deserted places for wolves, jackals, and birds of prey.

Many kinds of germs may grow and multiply in the deeper layers of cemetery soil, where the organic material is undergoing disintegration. The best coffins are the perishable ones made of wicker, light wood, or papier maché, and quicklime or carbon may be placed within.

The site for a burial ground should be where the soil is light and porous, so that air can pass freely through its interstices. It should also be drained to a depth of 8 feet, to help the passage of water, which must not be capable of getting into any source of water-supply, such as spring, stream, reservoir, or well. As a rule, therefore, cemeteries should not be on elevated spots. Loam or sandy mould is the most, and clay is the least, suitable kind of soil, and grass should be grown upon it. No cemetery can be built within 200 yards of a dwelling, unless the consent of both owner and occupier has been given.

Cremation.—An average body, on being burnt, becomes about 3 lbs. of inorganic ash within two hours, and for this purpose the fuel may be coal, coke, or gas. A ventilating shaft with pilot fire at its base is necessary. In the process the organic and volatile mineral poisons would be dissipated, and therefore such poisoning could not be detected. Cremation is not allowed, if the deceased has written directions to the contrary, nor if the body is unidentified, nor unless two medical certificates in accordance with the law have been given.

We learn from Dr. A. Wiedemann that the souls of the dead were pictured by the ancient Egyptians as gaining admission to the sun-boat, or to the wide-spreading fields of the blessed, or as among the stars. One of the ways of such access was, when a body was burned, for the soul to rise from the ashes heavenwards. However, this idea, though very ancient in Egypt, never prevailed widely in historic times, for the burning of the body, which even at the beginning of Egyptian history had become rare and practised almost exclusively in the case of kings, was in later times superseded by embalming. However, cremation was not forgotten, and traces of it are found in the second millennium B.C. in sacrifice offered at the burial of distinguished persons, when human beings were burned, so that they might be sent as quickly as possible after the dead man to act as his servants. The same idea of swiftly forwarding gifts was shown by "burnt offerings," a custom very different from the more common one of placing them in the grave. The latter plan implies at least a temporary sojourn of the dead man in the tomb.

Another way of transit suggested was that the soul rose to heaven as a bird, that of a king almost always in the form of a sparrow-hawk.

CHAPTER XVI.

APPENDICES.

APPENDIX A.

DURATION OF LIFE IN ORGANISMS.

THE different living forms display the greatest possible variations in length of tenure of existence. The life of some rotifers is probably concluded in a few days, that of insects may be a matter of a few hours, days, or weeks. On the other hand a pike or carp, a frog or toad, a raven, parrot, eagle, or swan, perhaps a crocodile, at any rate an elephant, or a human being, may live for a great number of years, sometimes for a century or even more. In this connection, although it has been said that vegetarians are usually long-lived, it cannot be assumed that the kind of food, whether animal or vegetable, has much or even any relevance. Elephants and parrots are vegetarian, whereas the equally long-lived owls, eagles, ravens, and crocodiles are carnivorous, and human beings have probably been, since the dawn of early intelligence, strikingly omnivorous. Nor can it be maintained that the burden of reproduction shortens life. More of this load falls upon women than upon men. Yet they more often reach a hundred years or more, and, usually, female animals also live longer than males.

1. LONGEVITY OF VEGETALS.

PROTOPHYTA, like protozoa, do not seem to exhibit natural death. Their rapidity of multiplication is shown by the fact of Euglena dividing so quickly as to colour a pond green, and that of *Protococcus nivalis* reddening a district, both in a single night. The prothalli of some cryptogams live only a few hours, producing sexual organs, and when these are ripe, the prothallus dies.

FUNGI live 7 to 15 days.

ALGÆ.—Fuci and other large species are perennial, but some are annual plants.

PHÆNOGAMS.—The higher plants may be classed thus :—

Annuals or semi-annuals grow up in spring and die in autumn.

Biennials die at the close of the second year.

Perennials may live from four to thousands of years.

Plants, naturally annual, may be so treated as to become biennial or perennial. In severe climates most are annual, and what difference of climate can effect is shown by the fact that the mignonette is a shrub in Barbary.

Succulent plants live only one or two years. Those strongly scented, e.g., thyme, mint, hyssop, marjoram, sage, live for two years or more. Lettuce, wheat, oats, barley, live only a year. Similarly shrubs which are scented live ten years or so, i.e., twice as long as unscented ones.

Amaryllis lutea sprouts leaves and flowers and makes seeds in ten days, and then dies; but in the same family there are plants notable for longevity. The agave requires a hundred years to produce its flowers, before death occurs. In many plants natural death can be prevented by making seeding impossible. It seems likely that poisons may be formed when the seeds are ripening. Possibly flowers, e.g., geraniums, die as a result of the local action of the poisons not strong enough to kill the whole plant. When natural death occurs in the higher plants, it may be due to auto-intoxication, just as bacteria and yeasts are killed by their own products. The dragon-tree, baobab, and cedar, which are long-lived, are not thus self-poisoned.

As above implied, ordinary shrubs live about five years, whilst odoriferous ones, e.g., sago, balm, lavender, last ten or more. Trees which grow quickly usually form soft wood, and do not live very long, e.g., some fifty years or so may be the duration of the poplar, willow, fir, birch, horse-chestnut. On the other hand, the trunk of an old tree is decayed, the bark gnarled, the branches shrivelled, the leaves scanty. Some trees live for hundreds or thousands of years, whilst others age early. In vast forests some of the trees may have existed at least many hundreds of years. The age varies from that of cercis, 300 years, to that of yew, 3,000, and to that of taxodium and adamsonia, even 5000 years, the age in these cases being estimated by rings of supposed annual growth, a mode of computation which, however, is not reliable.

Trees which have survived even thousands of years perish at last by some mishap. The famous dragon-tree of the Villa Orotava at Teneriffe, admired by Von Humboldt, was supposed to be several thousand years old, when its hollow trunk was at last destroyed by a storm. The baobab, too, is said to flourish for some five or six thousand years.

The oak grows slowly, forms hard wood, and lives long, though the beech, cypress, juniper, walnut, and pear produce hard wood, but do not live so long as the lime, which makes a softer wood. Trees, which take long to produce leaves and fruit and retain them long, live longer than those which produce them quickly. Wild fruit-trees, giving a sour, harsh fruit, live some sixty years perhaps. Cultivated ones, yielding sweet fruits, are not capable of such long life. Short-lived plants may be made to live longer by skilful pruning of buds and branches.

Hufeland stated that, in order to gain longevity, a plant (1) Must grow slowly; (2) Must propagate slowly and late in life; (3) Must have some solidity and hardness of organs, enough wood, and not too fluid sap: wood is necessary for long life; (4) Must be large and have much surface; (5) Must rise into the atmosphere.

According to Adamson, a baobab tree at Cape Verd was 5150 years old, and according to A. de Candolle, a cypress at Oazaca, in Mexico, was much older than even that aged tree. In California trees of the species *Sequoia gigantea* are said to be 3000 years old, and Sargent holds that some are at least 5000, whilst A. de Candolle suggests that there is no natural death of trees, which only die as a result of storm, stress, or accident. We append here an extract from *The Times*:—

The Oldest Living Tree.—A correspondent writes:—"It is difficult to realize, in these days of scepticism and higher criticism, that it is possible to see and handle portions of the branches of a tree under the shade of which both St. Luke and St. Paul, according to Dean Farrar, probably rested. In the island of Cos, in the Ægean Sea, there stands, jealously guarded, a huge plane tree, measuring nearly eighteen yards in circumference. It is surrounded by a podium, or raised platform, breast high, doubtless built to support the trunk of the tree after it had become hollow and weak from age. The lower branches are still well preserved, and have been shored up by pieces of antique columns, over the upper ends of which the branches have grown like caps, in consequence of the pressure of their own weight. Close by the tree is a solid marble seat, which is said to be the chair of Hippocrates, the father of medicine, and it is supposed that he taught the art of healing from that seat. He was born at Cos 460 B.C. This gives a clue to the age of the celebrated plane tree, which must be considerably more than 2,000 years old. Dr. Edward Clapton, formerly physician at St. Thomas's Hospital, whose devotion to archæology is well known, sent an agent a year or two ago to procure some fragments of the tree. This was done, but at considerable risk, as the Sultan, who attaches great importance to its preservation, has given strict orders that no one is to touch the tree, which is therefore guarded day and night. The specimens which Dr. Clapton obtained have now been generously handed over to the Royal College of Surgeons, where they will be displayed in the museum. They consist of two pieces of branch, a bundle of twigs from the branches, and a small box of leaves and round button-like catkins of the plane tree."

De Candolle compiled the following figures, which, though not to be thought exact, at any rate indicate that many trees reach a very great age:—

	YEARS.
Elm (*Ulmus campestris*)	335
Cypress (*Cupressus sempervirens*)	350
Cheirostemon platanoides	400
Ivy (*Hedera helix*)	450
Larch (*Larix europœa*)	576
Chestnut (*Castanea vesca*)	600
Orange (*Citrus Aurantium*)	630
Palms (*Ceroxylon* and *Cocos*)	600–700
Olive (*Olea europœa*)	700
Oriental Plane (*Platanus orientalis*)	720
Cedar (*Cedrus Libani*)	800
Lime (*Filia europœa*)	1076–1147
Oak (*Quercus robur*)	810, 1080, 1500
Yew (*Taxus baccata*)	1214, 1458, 2588, 2880
Taxodium distichum	3000–4000
Baobab (*Adamsonia digitata*) of the Cape Verd Isles	5000 (perhaps 6000)

2. LONGEVITY OF ANIMALS.

PROTOZOA.—It is probable that no such thing as natural death occurs in this group of unicellular creatures, nor is it seen in many polypi and some worms. Of course, they often fall a prey to stronger creatures, or succumb to adverse influences, but apparently they live so long as the conditions are favourable. Dr. C. S. Minot suggests that senescence occurs in a colony of unicellular creatures, unless conjugation and transfusion of protoplasm from cell to cell occur. As a rule, each protozoon breaks up either into two or more individuals, or, after contact with another, into several generative parts. Hence, though they lose separate and distinct individuality, their existence cannot be said literally to come to an end, i.e., unless they be destroyed—at any rate as a rule, and they have been described by some as "potentially immortal" (Weismann). Enriquez has brought about propagation of infusoria to the 700th generation without any detectable sign of senility.

CŒLENTERATA.—Some may possibly die early, after reproduction, even at a year old, and others seem to grow and reproduce for a long time. Sea-anemones have a very simple organization, being devoid of a separate digestive canal, and possessing only a badly developed and diffused nervous system. With care they may be kept alive several dozen years in a glass bowl. An *Actinia mesembryanthemum*, whose adult stage is reached at about 15 months, lived 66 years, and possibly may live 70 or more. Another, of the species *Sagartia troglodytes*, when 50 years old, only differed from younger ones in being less prolific. Other polyps, e.g., flabellum, only live 24 years as a maximum.

ECHINODERMATA probably die only as a result of mechanical injuries, or interference with their normal conditions of vitality. That is, they seem to live so long as their environment is generally favourable.

VERMES.—Most members of this class may be divided into several pieces, each of which forms a new worm. The turbellaria live more than a year. Rotifers as a rule die early. From the laying of the egg to the death of a male rotifer, called by Metchnikoff *Pleurotrocha haffkini*, the period is three days, not quite the shortest duration in the animal world.* The females live about fifteen days, and then die, possibly as a result of the poisonous excreta of the body. There are ephemeridæ which live only a few hours in the adult state, but in their larval stages they last months or even years, so that these male rotifers are really the shortest livers apparently, though it is possible that some kinds of rotifera may live longer. The annulata, or ringed worms, may perhaps live several years.

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* All male rotifers are devoid of mouth, stomach, and bowel, and therefore cannot take food, and live much shorter lives than the females, which have full digestive apparatus. Similarly, the dwarf males of a sea-worm, the *Bonellia viridis*, probably live a year less than the females, which are a hundred times as big, though they also have no mouth to the digestive tract. The dwarf males, too, of some parasitic copepods (lower crustacea) and the so-called complementary males of the cirripedes are gutless and live a shorter life than the females. The male Entoniscida, parasitic in larger water-crabs, can certainly nourish themselves; but die after coitus, whilst the females then first pass over to the parasitic life, and still live long, and produce eggs. (Weismann.)

CRUSTACEA.—Many smaller members of this group live but a year. Others live longer, e.g., the river crawfish is said to live 20 years.

INSECTA.—As a rule the imago lives from a few hours to 6 months, whilst the larva's existence varies from a week to 4 years in duration. Insects have been known to live in confinement 3 or 4 years, though it is said that 9 months is a very great age for fleas, The ordinary fly lives for about a day. Some females of the butterflies known as psychids (solenobia) lay eggs without being fertilized, and the life of these in the adult condition is only a day. Others are fertilized before laying eggs, and these can survive a week, though they take no food. Natural death is clearly shown by the ephemeridæ. The life of *Palingenia virgo* in the winged form lasts only a few hours, which are spent in the pursuit of love. After the males and females have paired, packets of eggs fall into the water, from which in a few weeks the larvæ are hatched. These have only vestiges of jaws, and cannot live. No microbe is contained in their bodies, nor is death caused by such phagocytic action as produces senile degeneration in mankind. As there are many more males than females, many of the former do not pair, and still die, so that it is not the mating that kills them. In some ephemeridæ death ensues after a few hours of adult life, though there is no sign of degeneration of the organs. Other ephemerids, e.g., chloe, survive for several days without food. When death occurs thus early in animals, it is probably due to poisoning by the products of life (auto-intoxication). All adult members of the group are easily captured, though the wingless larvæ are afraid, and attempt to escape.

A silkworm moth lives only a few days or weeks, a humble bee about three weeks. Female strepsiptera live sixty-four times as long as male ones. Some male butterflies live longer than the females (e.g., *Aglia tau*) because they spend much time seeking for them.

Several kinds of insects live only a few weeks. For instance, the plant-lice die within a month of birth. However, in the same order, viz., hemiptera, some species of cicada live from 13 to 17 years. Large grasshoppers and locusts have far briefer lives than many minute beetles (coleoptera). The queen-bees may live as long as 5 years, though usually less, but worker bees die in the first year. Female ants last as many as 7 years.

Many insects live only a few weeks. Insects include: (1) Orthoptera; (2) Neuroptera; (3) Strepsiptera; (4) Hemiptera; (5) Diptera; (6) Lepidoptera; (7) Coleoptera; (8) Hymenoptera. We now give some notes culled from Dr. August Weismann's *Ueber die Dauer des Lebens* (Jena, 1882), regarding duration of life in the interesting group of insects.

1. *Orthoptera.—Gryllotalpa:* In June or July the eggs are laid, and two or three weeks later hatched. The insects live through the winter, and are ready for fertilization in May or June. When the eggs are laid, the female's body becomes thin, and life lasts no more than one month longer, i.e., about one year in all. *Gryllus campestris* is mature in May,

and sings from June to October, when death occurs. *Locusta viridissima* and *verrucivora :* Females are mature at the close of August, lay eggs in the earth during the first fortnight of September, and then die. The mature condition of the female lasts not over 4 weeks. It is not certainly known if the lives of the males of these and other locusts be shorter. *Locusta cantans :* The members of this species are numerous from the beginning to about the end of September. If caught, the females live to lay eggs, and then die. Towards and at mid-September the males are much fewer than the females, and hence it may be inferred that they live a shorter time. *Acridium migratorium :* After deposit of eggs the female dies. *Termes :* Whilst the males live only a short time, the females probably reach 4 to 5 years. *Ephemeridæ :* The flight begins at sunset, and ends when the dew falls, well before midnight. When hatched, thousands fly about in the afternoon or evening. They pair at once, and all die the next day. Towards evening another swarm emerges from water, tree, bush, or ground. Birds, trout, and all kinds of fish hunt them. Dr. Hagen says that only with several kinds is the life so short as in *Palingenia*, which does not even survive till the opening of the sub-imago. Birth seems to be caused by actual rupture of the womb. *Dragon-flies :* A dragon-fly lives as imago a week, but all kinds of these flies are not alike. *Lepisma saccharina :* One lived for 2 years in a pill-box, and they seem to live whether supplied with lycopodium powder or not.

2. *Neuroptera.—Phryganida* live in imago condition—probably without nourishment—certainly a week, if not longer, according to Dr. Hagen. *Phryganea grandis* takes no food into the bowel—mostly air —so that the fore part of the stomach is quite blown up with it.

3. *Strepsiptera.*—These fan-shaped flies are remarkable little bee-parasites. The larva needs for its development a somewhat shorter time than the larva of the bee in which it has bored itself. The pupa stage lasts 8 to 10 days. The ardent circumambient males live in the mature condition only for 2 to 3 hours, whilst the wingless maggot-like females occasionally live several days. If 3 to 5 days old, they probably do not even mate, but die after 8 days, i.e., living sixty-four times as long as the males. The active females appear to bear young only once, and then to die. It is not certain if they produce parthenogenetically.

4. *Hemiptera.*—A parthenogenetically produced female *Aphis euonymi* was kept by Bonnet 31 days, during which it gave origin to 95 young ones. A female *Aphis mali*, also parthenogenetically produced, was kept 15 to 23 days by Gleichen. *Aphis foliorum ulmi* comes out from the winter-egg in May, and at the close of July is 2 in. long. It lives 2½ months. *Phylloxera vastatrix :* The males have no mouth nor digestive tract, and die after fertilizing the females, which they do soon after having been hatched, having lived about a day—a much shorter life than the females. *Pemphigus terebinthi :* Males and females are devoid of both wings and intestines, can take no food, and live only a brief period—a much shorter time than the parthenogenetic females of the

same kind. *Cicada:* Hildreth gives 20 to 25 days for the females; but as each lays about 1000 eggs, some time is required for this purpose. After 6 weeks all are gone. *Acanthia lectularia:* They can hunger for long and endure greatest cold. A female placed in a box, and then forgotten, was after 6 months of hunger not only still alive, but even surrounded by a bevy of living young ones. Göze is said to have found bugs, looking like white paper, in the hangings of a bed not used for 6 years, and De Geer kept bugs in the cold winter of 1772 when the temperature fell even as low as to $-33°$ C. in an unheated room, and they were living in the following May.

5. *Diptera.—Pulex irritans:* Die 2 or 3 days after laying their eggs. *Sarcophaga carnaria:* About 10 to 12 hours after fledging their lively young, the females die. *Musca domestica*, the common house-fly, lays several times, beginning 8 days after being hatched. *Eristalis tenax:* Weismann kept a recently-hatched female from August 30 to October 4.

6.—*Lepidoptera.*—Probably a butterfly in the imago condition does not live a full year, and in August they are only seen as rare curiosities, as was once a *Vanessa cardui*. *Pieris napi var. Bryoniæ:* Males and females after capture in the air lived 10 days in confinement and died. *Vanessa Prorsa:* 10 days. *Vanessa Urticæ:* 10 to 13 days. *Papilio Ajax:* Female 6 weeks, but perhaps only 3 to 4 weeks. *Lycæna violacea:* First brood of this species lives at most 3 to 4 weeks. *Smerinthus Tiliæ:* One caught lived 9 days, and survived egg-laying only 1 day, having taken no food. *Macroglossa stellatarum:* 6 days laying 80 eggs. *Saturnia pyri:* A pair hatched on April 24 or 25 remained in coitu from April 26th until the 2nd of May, i.e., 6 to 7 days. Then the female, after laying a great quantity of eggs, died. *Psyche graminella:* After mating, live several days afterwards, and, if coition does not occur, may live over a week. *Solenobia triquetrella:* The parthenogenetically produced kind lays, soon after being hatched, all the eggs in the neglected bag, falls then quite shrivelled from it, and after a few hours is dead. The non-parthenogenetic female remains several days sitting quietly, waiting for coition, and if this does not occur, lives longer than a week. The parthenogenetic females live scarcely a day, and it is the same with the parthenogenetic females of one other kind of *Solenobia* (*inconspicuella ?*). *Psyche calcella:* The males live only a very short time. Some, which were hatched in the evening, were dead on the following morning, lying with depressed wings at the bottom of their receptacle. *Eupithecia sp.* (*Geometride*) can be kept with good food in confinement 3 to 4 weeks. The males unite with the females several times, and these lay their eggs, even if they have already become quite weak, and unable to crawl and fly (Dr. Speyer).

7. *Coleoptera.*—Some certainly live for a long time, as the following instance shows (abstracted from Coupin & Lea's interesting work, *The Romance of Animal Arts and Crafts*):—

"Some of the wood-boring grubs attain to a very great age before their transformation, as was shown at the Natural History Museum in South Kensington. A small block of hard wood containing the

burrow of the larva of a longicorn beetle, which was then about 7 years old, was brought to the museum. The larva burrowed, and ate for 7 years, after its arrival. However, instead of turning into a fine beetle, the larva died at 14 years of age.

Melolontha vulgaris (cockchafer) lives not over 39 days, if carefully kept in an airy chamber, and supplied with fresh food. Of 49 cases, only one female lived so long, another 36, another 35, two females only 24, and the others shorter. Only one male lived 29 days. *Carabus auratus :* One caught May 27th lived only 14 days ; but this is really too short, for these beetles can be seen free from the end of May to the beginning of July. *Lucanus cervus :* Males when caught in freedom, and fed in confinement with sugar water: Dr. Zeismann has kept not over 14 days, and several live a shorter time. The beetles are seen only in June and July, and live certainly not much longer than 1 month. *Cerambyx Heros :* One lived in confinement from August to February of the next year. *Saperda Carcharias :* One lived from July 5 to July 24 of the next year. *Buprestis splendens :* One was found living cut out from a desk which had stood in an office 30 years. The wood must have held the larvæ from its being worked. *Blaps mortisaga :* One lived 3 months, two others 3 years. *Blaps fatidica :* One in a box forgotten, lived 6 years afterwards, when the box was opened. *Blaps obtusa :* One lived in confinement 1½ years. *Eleodes grandis* and *E. dentipes :* eight beetles from California were kept without food by Dr. Gissler 2 years, and then sent to Dr. Hagen, who kept them a year. *Goliathus cacicus :* One lived 5 months in a conservatory. Those beetles which live over a year, e.g., *Blaps*, also ants, *Pasimachus* (*carabide*), are to the extent of about 30 per cent much weakened, the whole cuticle dull, fissured, and the mandibles often cut off to the hypodermis.

8. *Hymenoptera.*—(*a*) *Gall wasps :* 3 to 4 days; (*b*) *Ants :* females, 3 to 4 years. Sir John Lubbock could keep a female worker of *Formica sanguinea* 5 years in life—also kept 2 females of *Formica fusca* near a dozen female workers, got from forest in Dec., 1874, until Sept. 25th, 1881, nearly 7 years, in imago condition. The female and worker ants may thus live even 7 years, but the males only a few weeks (3). Males and females are hatched in June, and mate in July and August, and the males die soon after mating ; (*c*) *Bees :* The larvæ of bees live 5 to 6 days, till the pupa stage is attained. Those of blue-bottles 8 to 10 days. The fresh-leaf-devouring larvæ of butterflies 6 weeks and over. The larva of the dragon-fly lasts 1 year. The caterpillars of the white-satin moth and those of wood-wasps, which consume wood for food, continue in this state 2 to 3 years, which is also the period of the larvæ of some *Ephemeridæ.* The queen-bee may live 5 years, but generally reaches only 2 or 3. The female workers live certainly always less than a year, as a rule not much over 6 or 7 months. Whether the female workers of the bees can live even so long depends on whether they avoid dangers. Most of those who live a free life come to destruction after a few months. Female ants possess capacity

for longer life than males, and this capacity must probably be latent in the egg. The eggs from which the queen-bees come and those from which the workers come are, probably, identical, and it is only the different feeding of the larvæ which determines the development of queen or worker. The presumable ancestors of bees, the plant wasps, live only a few weeks in both sexes. During coitus the male bee suddenly dies, and the queen-bee bites off the body. If they do not succeed in finding a chance to mate, they can live at most 4 or 5 months; but as a rule live a much shorter time, because the female workers cut them off from the honey, and drive them away from the hive. (*d*) *Wasps:* The males of *Polistes gallica* live at most 3 months, from July to the beginning of October; the parthenogenetic females at most a half month more, from mid-June to October: the later generations of the same a shorter time. Only the sexual females live a full year, the time of winter sleep being included.

ARACHNIDA, *Myriapoda.*—The larger kinds of spiders, such as tarantulæ, may probably live longer than insects.

MOLLUSCA, in common with crustacea, live for a long time, and have not been noticed to decline. If the antennæ of a snail are cut off, new antennæ will be formed, but if the animal be cut in two or more pieces, it will die.* Some molluscs probably live twenty years or more, if one judges from the rate of growth of the shell. Some species of gasteropods (*vitrina, succinea*) live only a very few years, whilst others may reach thirty. Some of the marine bivalves are perhaps capable of living even 60 or 100 years.

1. *Vitrines* live from spring to spring, and then die after spawning.
2. *Succines* live generally 2 years, *Succinea putris* perhaps 3.
3. *Pupa*, *Bulimus*, and *Clausilia* need scarcely more than 2 years for full development.
4. *Helices*, 2 to 4 years: *H. sericea, hirnida*, 2 to 3 years; *H. hortensis, memoralis, arbustorum*, 3 years; *H. pomatia*, 4 years.
5. *Hyalineæ*, for the most, 2 years; but the larger kinds may exceptionally live 3. The smallest of these and the preceding *Helices* at most 2 years.
6. *Lymnæus*, *Planorbis*, and *Ancylus* kinds live 2 to 3 years; *Lymnæus auricularis*, 2 years; *L. palustris* and *pereger*, 2 to 3 years. The last are found on the Bavarian Alps near Oberstorf, 4 years old.
7. *Paludineæ*, 3 to 4 years.
8. The small bivalves, *Pisidium* and *Cyclas*, 2 years. The large bivalves, the *Naiads*, often 10 years. *Unio* and *Anodonta* are at puberty in the third to fifth year.

SEA-MOLLUSCS.—The clam, *Tridacua gigas*, 60 to 100 years; *Cephalopods*, over 1 year; *Natica heros*, 30 years.

ASCIDIA.—*Cionea intestinalis* at 5 months reproduces and then dies.

BRYOZOA.—1 year.

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* However, not only feelers and eyes, but even a part of the head, if cut off, can be re-formed.

FISH.—Adults of the same species vary from 10 to 100 lb., and do not seem to get feebler as age progresses. Hence we infer that they live long, and this is probably true of most fish.

Lampreys.—In the imperial fish-ponds of ancient Rome, lampreys, it is said, lived more than 60 years.

Carp live to be 100 or more, perhaps 150. One said to be 150 and then active is said to have been seen by Buffon in a pond of the Comte de Maurepas. It has been said that they live to be 200, but this is doubtful.

Pike may live, it is said, 150 or even over 200 years. Gessner stated that one captured in 1230 lived 267 years afterwards. The duration of another's life of 90 years seems more probable.

Salmon.—Some, judged from the rate of growth, have been supposed to be 100 years old.

Halibut.—Judging from the slow rate of growth of some specimens that have been examined after being marked, it has been thought that halibuts may live from 80 to 100 years.

AMPHIBIA.—Fish-like forms probably live as long as fish, and batrachia show senile decay. Some small frogs live 12 and up to 16 years, and the toad 36 or even 40. Newts and salamanders can renew tail and limbs that have been lost.

REPTILIA.—Some, e.g., chelonia and crocodilia, appear to grow very slowly as long as they live, and live a long time (over 100, and possibly even 200 or 300 years), and therefore vary very much in size. Others, as the lacertilia, live only for a brief period, and are more constant in size.

Crocodilia.—Crocodiles and caymans are large reptiles which grow very slowly and live long. There is no early limit at any rate to the time of growth. In Paris crocodiles have been kept more than 40 years without showing any signs of senility. Some sacred crocodiles in India were said to have been there since the Conquest, but, without believing this statement, we may say their possible age may perhaps be about 100. It is noteworthy that a crocodile or tortoise is not harmed by the tetanus bacillus, and possibly they may be also able to resist other deadly germs. For example, it has recently been found that the trypanosome of sleeping-sickness in man is obtained by the fly which conveys it to man from the crocodile, and hence it has been proposed, and we believe decided, so far as possible to exterminate these creatures in belts of territory where the disease is rampant.

Chelonia.—Prof. Metchnikoff possessed a male tortoise (*Testudo mauritanica*) aged 86 years. It was devoid of any sign of old age, and sexually virile. Another, a water-tortoise, has been kept in the garden of the Governor of Mauritius 140 years, and as it was at least 10 or more in all probability when brought there from the Seychelles, it must have lived for at least 150 years. Another, a native of the Galapagos, judging from its rate of growth in the London Zoo, was thought to be 175 years old. Another in the same gardens was supposed to be 150. Another from the Cape, which had been in the

Governor's garden 80 years, was thought to be 200 years old. Another, brought to Fulham Palace by Archbishop Laud, lived there 128 years. It may be noted that the tortoise's heart beats only 20 to 25 times per minute.

In general, the possible age of the tortoise is given as about 100, but the Aldabra tortoises live from 90 to 150. The Galapagos tortoise, like the American alligator, may grow rapidly, and hence probably their duration of life is not so great as was formerly supposed.

Birds.—Snipe* and woodcock probably live 3 or 4 years, many small birds 5 or 6, kestrels 6, starlings 8, several little song-birds 8 to 18, nightingales in captivity 8, or perhaps a little longer. A bastard nightingale nested 9 years in the same garden. Pigeons 10, blackbirds in captivity 12. When free, blackbirds and nightingales live longer, perhaps 12 to 18. The barn-door fowl 6 to 20, falcons 12, canaries 12 to 15 or 20 (?), goldcn-pheasants 15, turkeys 16, peacocks, owls, and, according to some, blackbirds and canaries, may reach 20, owls living much longer in freedom, goldfinches 23 in captivity. Many cases of long life in birds carefully tended by man may exceed the natural limits, and probably the goldfinch's natural life is about 20. Captivity may, according to various circumstanccs, either shorten or lengthen existence. Field-larks 24, ducks, which are very fertile, and though taking rather nasty food are still very tasty for the table, may reach 20 or even 30 years. The lesser black-backed gull lives 31 years. A cuckoo is said to have lived 32 years. Eider-ducks 20 to 100, and stilt-birds and birds of prey much the same. The herring-gull 44. Geese, swans, crows, and some birds of prey may live 50, and the goose has been said to reach 100.

We gather from Mr. J. H. Gurney that a condor lived to be 52, an imperial eagle 56, a heron 60, one eagle-owl (*Bubo maximus*) 53 and another 68, one raven 50 and another 69, a swan 70, and a wild goose 80.

As for parrots, especially if safely and healthily protected, it has been said that, like birds of prey, they may live cven 80 or 100 years. Of 40 parrots the minimum and maximum age were respectively 15 and 81 years, and the average 43. Metchnikoff mentions an amazon dying at 70 to 75, and another at 82, whilst M. Abrahams recorded one of these (*Chrysotis amazonica*) as having lived 102 years, and even 120 has been said to have been reached by a parrot.

Cockatoos may livc eighty or more years. A parrokeet or parroquet lived at Florence for 100 years, and at death was 120. A South American parrokeet, eighty-two years old, was less lively than in previous years, and less bright in plumage, had diseased joints in its claws, but did not turn white. Generally speaking, birds, especially in the wild state, live long, and show but few of the ravages of senility. Swans, ravens, and crows may perhaps live to be centenarians.

* The little jack-snipe are the best of the snipe tribe for eating, the fine-looking, fuller snipe not being so good. They are also at best, like celery, oysters, and truffles, after the first frost. (*The Times*.)

Eagles and falcons may exceed a century. A golden or stone-eagle, caught 104 years previously, died in 1719 at Vienna, whilst another died at 80. According to Mr. Pycraft (*Country Life*, June 25th, 1904) a female eagle captured in Norway in 1829, was taken to England, where it lived 75 years, yielding 90 eggs in the later 30 years of its life. Moreover, a white-headed vulture, captured in 1706, died in the Schönbrunn Menagerie, Vienna, in 1824, having thus lived therein 118 years. Large kinds of falcons have been credited with reaching 162 (182 by some), and ravens also have been reputed to be capable of reaching 180; but these are probably exaggerations, though not so extreme as the fact of 300 years being attributed to swans.

It is only in the large running birds that the large intestine has much size. For instance, in a *Rhea americana* the weight of the two cæca with their contents was more than 10 per cent of the total weight of the bird. In correspondence with this larger development of the large intestine of cursorial birds, we find that they do not live long. The maximum for ostriches is about 35 years, whilst an emu may live 23, and the *Rhea americana* only about 15. Thus we see that the adaptation to terrestrial life, involving as it seems to do the growth of a huge large intestine in which microbes abound, occasions a shortening of life. On the other hand, bats, which are flying mammals, have a small large intestine in adaptation to their aerial life, and it has only a few bacteria. Fruit-bats fed on apples and bananas produce excreta with the pleasant odour of those fruits. One of these has lived 15 years in the London Zoological Gardens. Owls are nocturnal birds of prey, and they have very long cæca. Eagles with very short cæca and owls with long cæca have about the same longevity, and both have very few microbes in the intestine.

As a rule, small animals do not live so long as larger ones. Yet parrots, ravens, crows, and geese live much longer than many mammals, and than some much larger birds.

Mammalia.—This is the only group of animals possessing a greatly developed large intestine. The processes of digestion and assimilation are rapidly performed in the stomach and small intestine, in which latter the food remains a shorter time than in the large bowel. It is only when, owing to disease or disorder of the small intestine, its contents are very rapidly passed on to the large intestine without having been digested, that the latter acts in any marked degree. Normally the large intestine quickly absorbs water, and acts mainly as a reservoir for convenience' sake; but it has some digestive power as above stated, and as is shown by the fact that rectal injections of milk or beef-tea or other nutritious material are serviceable when food cannot be taken by the mouth. Cancer is more frequent in the large intestine and stomach, owing perhaps in each case to the longer retention of their contents. Of 1,148 cases of cancer of the alimentary tract in the Prussian hospitals during 1895–6, it was found that 89 per cent affected the large, and only 11 per cent the small, intestine. Also, of 10,537 cases of cancer of all parts of the

digestive tract in the same period in the Prussian hospitals, 4,288, or more than 40 per cent, occurred in the stomach.

Mice live about 5 or 6 years, rats, rabbits, and several other rodents seldom more than from 5 to at most 10 years ; but all these creatures reproduce with enormous rapidity. Rabbits, however, often live 8 and even 10 years.

As a rule from 7 to 10 years may be stated as the age-limit of guinea-pigs, hares, sheep, goats. Goats may, however, reach 12, and foxes 14. Sheep lose teeth at from 8 to 10, and may live 12 to 15 years. The pig, ox, wolf, jackal, dog, and cat live 15 to 20 years. Recently we saw a cat of about 20, which looked decrepit, thin, sleepy, and inactive. She was almost toothless, save for a few smallish black stumps. Life had been for some years dependent on the fostering care and protection of the owner, who supplied delicate food, and allowed shelter near the fire and on the oven-lid at nights. The poor creature, on being seen by me, appeared to be ill and rather an object for pity. Some weeks ago, viz., December 9th, 1908, it was reported to be still living, and what is more, in a better state of health and strength, than when seen by us some two winters ago. The owner has removed to another village (Utterby, near Louth), and perhaps the cat may have benefited by the change of air and surroundings, for cats, like human beings, may certainly enjoy an alteration of habitat. Instead, too, of requiring so much shelter indoors, she now sleeps out of doors in an empty pig-sty, on a bed made of some old rags and sacking. Metchnikoff speaks of a cat aged 23 which he possessed. It died of cancer of the liver.

Twenty years may be reached by dogs, oxen, lions, swine, and 25 by boars. Dogs, however, are senile at 10 to 12, and seldom live more than 16 or 18 years. Jouatt speaks of a dog aged 22. Some may have lived to be 30, and Sir E. R. Lankester mentions one of even 34.

Domesticated oxen show a yellow discoloration of the teeth when 5 years old, in the 16th to 18th year the teeth fall out or break, the cow then ceasing to yield milk, and the bull to have reproductive power. Brehm says they live 25 to 30 years or more. The gestation-period of a cow approaches that of a human being, there is only one birth per year, and the reproductive period only lasts a few years.

Several lions, kept in menageries, after loss of teeth and blunting of claws, which might have terminated their lives if wild, at 35, have lived 40, 50, or even 60 years.

The elephant in captivity has rarely, but occasionally, lived to be 100. As a rule, in zoological gardens and menageries they seldom live more than 20 to 25 years. The epiphyses fuse with the shafts of the bones at about 30, and probably later as a rule, and hence, according to the rule of M. Flourens, the elephant should live 150 years. An elephant is said to have been used during the period of 140 years that Ceylon was occupied by the Dutch. Natives, accustomed to these creatures, say they begin to grow old at 50 to 60 years, but live 80 to 150. It is probably similar in regard to length of life to human

beings. However, it is noteworthy that in the official list of the Indian Government, only one out of 138 elephants lived more than 20 years after it had been purchased. These animals have enormous large intestines with capacious cæca, and may be said to live 100 years.

The fur-seals probably do not reach over 20 years. The age of the Greenland whale has been estimated from the rate of growth of the baleen to be from 300 to 400 years, but this is probably an absurd, or at least a greatly exaggerated, estimate. Whales do not vary so very greatly in size, and, according to Mr. F. A. Lucas, of the Brooklyn Museum, even the age of 100, almost universally allotted to them by writers, is erroneous. He suggests about 25. The leopard, bear, and tiger may live 25.

As for the horse, the extreme limit is usually said to be 40, but ages of 46, 50, and even 60 have been mentioned, probably in error.* Many, from ill-usage, overwork, or excessive exertion, die before 9 or 10, and often very suddenly; most show some senile change at about 10 or 12 and die before 15, whilst with care some have lived to be 27 and even 30, and a Bishop of Metz had one of 40. It may even be possible that this age has been exceeded. Asses live to be 25 to 30, and mules probably a little longer.

Dolphins live 30, deer or stags 30 or 40, bears 50, camels 40, 50, or perhaps even 80 or 100 years; an Indian rhinoceros lived 37 years in the London Zoological Gardens, and the possible age of a rhinoceros or hippopotamus has been said to be 75.

It has been said that monkeys live to a good age, the anthropoid apes possibly reaching half-a-century, but some apes seem to be much shorter-lived and only to attain an age of 10 years. From the following table, which we regret not at present to be able to more thoroughly perfect, it is seen that the mouse becomes capable of reproduction at 4 months, is fully grown at 6 months, and lives 5 years, twice as long as would accord with the quintuple ratio of life to growth. A sheep may be said to be adult at 5, when it gain its adult teeth, which are lost at 8 or 10, at which time other senile changes begin, and become marked at 14, when decay sets in. This ratio is only about half the quintuple one, for the sheep does not live even thrice its period of growth.

Again, parrots are able to reproduce when 2 years old and are then adult, and, moreover, their incubation is not more than 25 days, and yet they live very long, even to 80 and more. Likewise, geese have a short period of growth, and also a short incubation, and yet they also live 80 and even 100 years. Ostriches, however, whose period of growth is about 3 years, and incubation about 45 days, live only about 35 years. The horse's period of growth is about 4 years, and

* The age given here and by most authors for horses is much greater than our own experience shows. Our coachman says the oldest horse he knew was one of 28. We are now driving a fine mare of 19; but at about this age special food must be given, the oats, i.e., being rolled before given as food, for the teeth become then defective and inefficient.

yet that animal may reach 40 years of age, though as a very exceptional occurrence.

Name	Period of Gestation in Days	Age when sexually mature	Time taken in growth	Extreme Duration of Life
Mouse	—	4 months	6 months	5 years
Guinea-pig	—	7 months	—	7 years
Goose	—	—	—	80 to 100 years
Parrot	25	2 years	2 years ..	80 years
Ostrich	45	—	3 years ..	35 years
Kangaroo	38	—	—	—
Bat (*Vespertilio noctula*)	40	—	—	15 to 20 years
Rabbit	—	3 months	Within 1 year	5 to 10 years
Cat	56	6 months or so ..	Before 1 year ..	23 years
Hare	—	4 months or so ..	1 year ..	8 years
Dog, wolf, jackal ..	63	12 months or so (?) ..	2 years ..	12 or 15 to 20 years
Lemur *albifrons* ..	105	—	—	—
Pig	120	2 years	—	15 to 20 years
Marmoset	120	—	—	—
Monkey (*Cebus*) ..	150	—	—	10 to 40 (?) years
Hippopotamus ..	234	—	—	—
Red and Fallow Deer	245	—	—	30 years
Roe deer	280	—	—	30 years
Human being ..	280	14 years	20 years	110 years
Lion	—	—	4 years ..	20 years
Sheep	—	One year; but not well able until 2 years, i.e., the offspring earlier begotten is not really vigorous and matured ..	5 years ..	14 years
Ox	286	2 years	4 years ..	20 years
Ass	330	2 years	3 years ..	15 years
Horse	330	2 years	5 years ..	25 to 40 years
Camel	—	—	8 years ..	40 years
Giraffe	440	—	—	—
Elephant	593	—	20 years	100 years

Man should live to be at least 100 or more, but human life is in many ways artificially restricted, and often so very difficult for the old, that it is much shortened. Throughout Melanesia it is customary to bury alive old men incapable of work. When famine seems at hand in Tierra del Fuego, the old women are killed for eating before recourse is had to the dogs, on the grounds that the latter catch seals, whilst the former do not. The old women flee to the mountains, but are pursued and taken home to be killed. Such methods have their

echo in attempts on the lives of old men and women even in the most civilized countries of Europe. Moreover, old people often end their lives by committing suicide, especially if, destitute or ill, or both, they think death to be preferred to an unhappy life. In 1878 in Prussia there were 154 suicides per 100,000 persons among men from 20 to 50 years of age, and 295 of men between 50 and 80. Similarly, at Copenhagen from 1886 to 1895, there were for every 100,000 individuals 394 suicides of men from 30 to 50, and 686 from 50 to 70. Hence those in the prime of life furnished 36½ per cent, and the aged 63½ per cent, of suicides.

However, the desire for life increases with age. Though it be impossible to live, act, and love, the desire is unappeasable to do so. Moreover, the faculties are often retained to advanced age. Goethe lived in full productivity of talent until 84, though in youth depression made him think of suicide. It is quite possible that human beings should live to 150. It may be well to develop the instinct of life in the earlier part of life, and then practise what has been learnt by experience and research as to the means of keeping healthy. This kind of knowledge is not easily gained. It is wise to see that our servants remain healthy, to control temper, avoid luxuries, heavy meals, assemblies, and society, and to restrict the racial instinct. Anthropoid apes and many other species have vanished, and perhaps man may vanish also. However, everything depends on carefulness in regard to health, and we must keep on learning.

It is said that one human being dies on the average for each second of time that passes. The death-rate is about 2 per cent of the population per annum, taking an approximate estimate for all the world, and since the number of human beings in the world is probably about 1,500,000,000, the number of deaths each year amounts to about 30,000,000. During the life of a human being of 80, about 2,400,000,000 fellow-creatures will have died. A great many of these deaths are avoidable, for there is a much greater capability of life in human beings than is usually attained to. In the very aged death is much like a deep sleep, and there may be no very marked changes seen in the organs if an autopsy be carried out. It is probable that in some cases the body manufactures poisons in the large intestine which cause death. Activity of the body and temperance favour life, and it is probable that an idle person cannot live very long as a rule. Indolence brings the penalty of ill-health and short life.

The average mortality for the Kingdom of Great Britain about 1850 was about 22 per thousand, yet in Rothbury and Glendale in Northumberland, doubtless a most salubrious spot, partly on account of the proximity of two oceans, and at Eastbourne in Sussex, also favoured by sea-breezes, it was only 15.

Mr. Griffith Davies said that out of the same population there died annually from 1720 to 1730 the number 106, and from 1730 to 1740 only 104, and gradually in successive decades less, until from 1810 to 1820 the number was only 62.

EXPECTANCY OF LIFE.

Ages	England and Wales 1838-54 (Farr's Tables)	Experience of 17 English Offices, 1843	Ages	England and Wales 1838-54 (Farr's Tables)	Experience of 17 English Offices, 1843
0	40·9	—	60	13·9	13·77
10	47·4	48·36	70	8·7	8·54
20	39·9	41·49	80	5·1	4·78
30	33·3	34·43	90	2·9	2·11
40	26·7	27·28	95	2·2	1·28
50	20·1	20·18			

The above table shows that ordinary medical foresight lessens the risk of insurance up to the age of 50, but after that age it is to be supposed that medical examination conducted early in life does not do so. It might, however, certainly do so, if the examination were conducted or repeated at a greater age.

It seems that for every 100 female children born in this country, 103·5 males on an average see the light of day, and the numbers in England and Wales in 1901 were :—

All Ages		Under 1 year	1 year	2 years
P. ..	32,527,843	796,807	727,795	735,410
M. ..	15,728,613	399,875	363,424	366,824
F. ..	16,799,230	396,932	364,371	368,586

It seems strange that more male children should die than female, but perhaps they, being apparently more vigorous, are taken less care of. At each subsequent age-period (except 14 and 15) the females exceed in increasing proportions. The advantage in numbers on the part of males is again lost at 16, and again increasingly lost thereafter. If the islands in the British seas be included, the numbers of males were 15,799,189 and of females 16,879,024, and hence the females outnumbered the males by 1,079,835.

Britain, especially Ireland, Sweden, Norway, Denmark, Hungary, Russia, Greece, and Bulgaria are famous for longevity. In some far distant northern countries and parts, it has been said that 70 is seldom exceeded. Out of each 10,000 persons buried, in London 36 reached 90, and 2 to 100. In England generally 89 reached 90, and 4 to 100. Cornwall 137 reached 90, and 6 to 100. Wales, 211 reached 90, and 13 to 100.

The proportion who reach 80 was found to be: in Pays de Vaud (Switzerland), 1 in 21½, in Norwich 1 in 27, in Edinburgh 1 in 42.

The majority of the long-lived in England have been in the counties lying towards the East, Yorkshire coming first, Middlesex, Shropshire, Cheshire, Staffordshire, and Surrey being also good.

In a level country sloping to the south on the borders of Siberia, it was said a year has seldom passed without a death at 130. It was also recorded that in the year 1835 there died in the Russian Empire 416 aged 100 and more, the oldest being 135, and there being 111 aged over 110. Also in 1839 there were 858 from 100 to 105, 126 from 110 to 115, 130 from 115 to 120, 3 from 120 to 130, 1 at 145, 3 from 150 to 156, one at 160, and one at 166.

In Great Britain and Ireland there were from 1850 to 1853, one thousand deaths amongst the Friends. Of these 517 reached 60 years, of whom 353 reached 70 years, of whom 141 reached 80 years.

The average age of persons living beyond 51 was found to be, in the case of the learned professions generally, 74½, clergy 74, medical men 73, lawyers 72¾. If the most eminent men in each class were alone considered it was for medical men (baronets, etc.) 74½; clergy (archbishops and bishops) 70¼; lawyers (judges, etc.), 67.

In the census of 1851 the persons who recorded their age as over 100 and up to 119 years, included 111 men and 208 women, but these were probably in part errors of misstatement. In 1901 at least there were far fewer self-styled centenarians, but doubtless these are more veracious statements.

Ages of those above 80 in England and Wales, 1901 :—

	85	90	95	100 or more
Persons	38,961	8,202	1,190	146
Males	14,915	2,687	322	47
Females	24,046	5,515	868	99

Most of the recorded very long livers lived at times when accurate notes were not kept, and are probably cases of misapprehension or mendacity. Dates of events were fixed by comparison with other events supposed to have occurred at about the same time, and hence it was quite easy to make great mistakes.

The average duration of life in Europe is about 34, in Prussia 28·18, in Schleswig-Holstein, Lauenburg, 39·8, Naples 31·65. Great mortality in early life much reduces the average.

Laplanders may live to be 70 to 90. American Indians and Negroes seem to live as long as white men in the same locality. A census of New Jersey gave one negro centenarian to 1000, and one white to 150,000, but this may have been inaccurate. Negroes of the Senegal age early, and do not live long, although they resist the native insanitary factors better than the white man. If taken to America, they live longer.

Few emperors or kings have reached 80, and of more than 300 Popes only 6 have exceeded 80. Statesmen, judges, and men eminent in literature and science have often lived long.

Hufeland recorded that Dr. Longueville, of France, lived to be 110, and married ten wives, the last of whom, wedded when he was 99, bore him a son when he was 101. The same author points out the benefit of slow eating. For 60 years the centenarian, Cornaro, took only 12 oz. of food and 13 fluid oz. of liquid daily. Shakespeare died at 52,

Haydn at 78, John Wesley, who gave up flesh in mid-life, at 88, the Apostle John at 93, Michael Angelo and Titian at 96, Cornaro at 100, Hippocrates at 102 (but according to some 109).

In the *Daily Chronicle* of Tuesday, Dec. 24, 1907, we read of the serious illness of Mrs. Sarah Bramley, of Nottingham, who entered the workhouse there 44 years ago, and was aged 108 at the time of writing. This and other like long ages remind us of the text, Genesis vi. 3, " And the Lord said, My spirit shall not always strive with man, for that he also is flesh: yet his days shall be an hundred and twenty years." Other recorded instances are as follows, but one cannot of course believe most of them to be veracious, though many of those up to 110 may possibly be accurately stated.

Of course, as everyone knows, some perfectly absurd tales are told of the length of certain peoples' lives, and many seem to think that the Biblical records as to Methuselah and other long-lived patriarchs are to be taken literally. Hence they see no wonder perhaps when they hear tales of a man at Dantzic having lived to be 184 years old, and of another at Wallachia said to have died in 1840 at 186, nor of Thomas Cam, St. Leonard, Shoreditch, who was reported as dying at the age of 207 on Jan. 22nd, 1588, nor of Demetrius Grabowsky, who was said to have died in Poland aged 169, nor perhaps of even Nieman de Cuqna, a native of Bengal, whose life is said to have lasted for 370 years.

Henry Jenkins, who, they say, testified to an event which occurred 140 years previously, and lived near Catterick, Yorkshire, is reported as buried in the Church of Burton-upon-Swale, at the age of 169, and only one year younger, viz., 168, is William Edwards said to have been, when he died and was buried in the Caerey Church, Cochen, near Cardiff, Glamorganshire. Thomas Parr, Shropshire, was said to have reached 152 years 9 months, and a grandson of his died at Cork some years since aged 103. Effingham, it was said, died in Cornwall in 1757, aged 144.

More likely to be true are the following cases :—

Elizabeth Watson, Leathley Almshouses, Leathley, West Riding of Yorkshire, was able to converse amusingly at 103. Born at South Kirby in 1795. Grandfather died at 108, grandmother at 105, and an uncle at 113, husband at 99 (*v. Golden Penny*, Aug. 20, 1898).

The *Golden Penny* of Oct. 8th, 1898, records also that Mr. Robert Taylor, of Scarva, died July 25th, 1898, aged 134 years. Did not marry until 108.

Mrs. Anne Armstrong, of Mulltown, Malbay, died a few months before October, aged 117. Good sight and memory, but defective hearing. Retired to bed between 4 and 5.

Mrs. Margaret Ann Neave was born May 18th, 1792, and was thus in her 106th year in 1898, and lived at Rouge Huis, Guernsey.

Mrs. Sarah Ann Smith, Grantham, passed her 101st year, and was still in possession of all her faculties.

An Irish landowner, Brawn, is said to have lived to 120. In France

150 centenarians die annually, and in Greece they are proportionately nine times more plentiful. Both dwarfs and giants have been 100 at death.

A butcher, who died in France in 1767, aged 120, is said to have been drunk twice weekly during the greater part of his life, and a lady in Saxony, who lived to be 114, took 40 small cups of coffee daily.

We append the following from the *Daily Chronicle* of Tuesday, January 24th, 1908 :—

"Had it not been for the mishap she would probably have lived many years longer," said a doctor at the inquest yesterday, at Bristol, into the death of Mrs. Honor Coleman, a widow, aged 107, who died from the result of an accident.

Ellen Lansbury, aged 75, deceased's daughter, said her mother was going to bed on the evening of January 7th, when she slipped and fell to the ground. She was attended to by her eldest daughter, aged 87, with whom she lived, and who now lies seriously ill as the sequel to her mother's death.

A verdict of "accident" was returned.

Strangely enough, Mrs. Honor Coleman's mother was drowned at the age of 101 whilst walking over a plank across a stream. None of the family, it is their proud boast, died before 87 years of age.

Deceased some time ago was photographed with Dr. Weatherly, chairman of the local board of guardians, who is in his 88th year. A copy was presented to the board, and hangs in the board room.

The coroner, Dr. Craddock, yesterday congratulated deceased's daughter, and expressed a hope that she would live as long as her mother, "if not longer."

In *The Times* of Dec. 11th, 1908, we see recorded the death of Mrs. Warr, born in Oxfordshire, who recently died at Wealdstone, aged 107, and is said to have attended mass at the Wealdstone Roman Catholic Church on her previous birthday (106th).

We read in *The Louth Advertiser*, Dec. 5th, 1908, that: "Mrs Mary King, 9, Spring Side, celebrated the 103rd anniversary of her birth on Wednesday, and we are glad to hear that she still enjoys comparatively good health." It is not very long since we saw this lady, who then showed a wonderful retention of all faculties. We believe she is really 102, and we have recently been informed that she can still hear fairly well as a rule, and can see to read her Bible, a duty daily performed when well enough, also that she can enjoy her meals, and eats a good supper usually every night. It is very encouraging to all who look forward to a long life, to see this wonderful old lady, and to hear her say she is glad "that things is as they is."

APPENDIX B.

CHANGES WHICH OCCUR IN AGED PEOPLE.

ONE of the most characteristic marks of healthy youth is a possession of resiliency and elasticity of structures, and consequently of a certain ease and grace of movement. This in many aged persons has disappeared to a greater or less extent. No doubt the absence of this property is partly caused by diseases such as gout, rheumatism, influenza, febrile and other disorders ; but even in healthy old people who have not suffered much in respect of such maladies, there is also a loss of elasticity which may be put down to loss or impairment of the elastic tissues of the natural body.

This elastic tissue, whereby elasticity is imparted to the lungs, the arteries, and some of the membranous surfaces, is very important. For instance, the expiratory function of the lungs, the elastic recoil of the arteries, and the expansibility of the channels, depend upon its activity. If the fluid expectorated be found to contain curly elastic filaments, the lungs may be supposed to be in a state of incipient phthisis, for they are early signs of lung-destruction.

Metabolism in the old is very similar to that of adult life, though that of the young is different, as they cannot digest a varied diet. In aged people the cells give off less heat whilst at rest. Also the old have not the same great desire for much food as the young have, and in fact they usually take less than is sufficient to maintain their weight. Even if rich, old people gradually lose weight as a rule, though not so much as the poor, though it is not always true that everyone over 70 or even 80 years will show a diminution, nor that the old who are losing will necessarily do so every year. The metabolism may fall to 20 to 80 per cent of the normal standard. Old residents in workhouses eliminate about 5 to 12 grams of urea and 5 to 8 grams of nitrogen—daily. It is noteworthy that old people need only little albumin.

The motions of the old are not either large or frequent, and the absorption of fats is as marked in the old as in the young.

The blood of the aged contains a diminished number of cells. Quinquaud found 3,640,000 red corpuscles per cmm. in old people of 87 years, and Duperié and Sörensen found from 4,200,000 to 4,700,000 in persons over 70 years.* The hæmoglobin is said to be slightly less, the sodium hydrate (NaOH) about the same, viz., about ·25 gram to

* The red cells on the average in man number 5,000,000 per cubic millimetre, about 450 times as many as the white cells.

100 cc. The cholesterin is also slightly increased, and the urea may be high, if the food be well taken, owing to slower eliminative power of the kidneys.

The skin of the face of the aged is generally dry, wrinkled, and pale. The hair is for the most part grey or quite white. The body is more or less bent. The walk is difficult and slow, the memory poor. Hair is not always lost, for those persons who have not begun to lose it whilst young will not do so during old age. Both weight and stature diminish. In stature, between 50 and 85 years of age, men lose a little more than 3 centimetres, and women 4·3, though even 6 or 7 centimetres may be lost. According to Quetelet, the maximum weight of men is at 40 years of age, of women at 50, in the general way, though there are many exceptions to this average. From 60 years of age the weight diminishes, and at 80 years the loss amounts to about 6 kilograms.

The diminution in stature and weight of the aged is due to a general atrophy which affects muscles, viscera, and bones. All these are lighter in weight. It might be thought that diminished elasticity was due to an increase in the proportion of mineral matter in the bones, but the contrary is true, for there is a less amount of this in the bones of old people. In old age the bones atrophy, showing a very slow loss of lime and phosphates. The blood-vessels and the marrow become larger in amount, and so partly fill the place of the lime and phosphates. Hence the osseous framework is lighter and more brittle, i.e., more easily broken. The neck of the femur particularly beomes atrophied, and is not infrequently fractured in the aged. For example, Virchow, when 82 years old, whilst descending from a tram made a false step, whereby the neck of that bone was broken. After several months in bed he died. Brittleness of bones in the old is caused by cellular multiplication and the production of large giant cells (osteoclasts), which destroy the osseous lamellæ and make the bones spongy. In the old the body becomes stiff, and their backbones are often curved and bent down towards the ground.

Muscular power is said to diminish in aged males more than in aged women. In both the movements of the body are not only slower, but also less graceful, symmetrical, and resilient.

Debility of muscular movement is due to changes in the fibres, but not to loss of reproductive power of the cells. The bundles become thinner, and there is a deposit of fat-granules in them. The nuclei of the fibres are abundantly multiplied and arranged in long series. The nuclei and substance surrounding them are multiplied and devour the contractile substance. The muscles become pale, diminished in size, and the fat lying between the bundles of fibres is less in amount. They become also hard and tough, as we shall soon see also do the organs, such as liver and kidneys, whose leathery condition is spoken of as sclerosis. Not only do the organs and viscera become thus hard, but they also diminish in volume and in total weight, some losing more than others.

Thc parenchymatous elements, which are the esscntial cellular parts of the muscles, as well as the kidneys, liver, brain, and other organs, atrophy, and the connective tissue actively grows and causes hardening. This hardening may oecur in isolated patches, or may affcct the whole periphery or even interior of the organ. The prostate gland sometimes beeomes hypertrophied in old men, but as a rule most of the organs atrophy. This hardening is seen in the so-called eirrhosis of the liver or of the kidneys, and in sclerosis and atrophy of the arteries, which last eondition is the root of many senile modifications. In the joints there may be ealcareous deposits which weld the bones together, and the cartilages between the vertebræ, becoming ossified, join the vertebræ morc or less completely. The skin and the mucous membranes remain mueh the same, but the connective tissues alter to a marked extent.

Some have suggested that old age is due to loss of power to replace lost cells by a sufficient supply of new elements of the tissues, i.e., that the supply of new cells is not sufficient to repair those lost, and there is no doubt that cellular growth is most active during embryonic life. This, howevcr, does not seem to be true. At any rate, so far at least as the hair and nails are concerned, there is no sueh loss of power, for these continue to grow throughout life by proliferation of their eomponent cells, and this cven in the most advanced age. The hair of certain parts aetually inereases markedly in quantity and length in the old—at any rate in some eases. In the Mongols and also some inferior races the moustaches and beard do not grow actively until late, and in white fcmales the hair on the face grows only as a rule in advanced life, so as to produce the moustaehes and beards of some elderly females.

Dr. Pohl found, in a man aged 61, the hairs of the tcmples grew 11 mm. in a month, and in boys from 11 to 15 they only grew 11·8 mm., or even lcss than 11 and always less than 15. Also the hair of a youth between 21 and 24 in different parts of the scalp grew 15 mm., and at 61 lowered to 11 on the temples, where, however, it grows more slowly than in other parts.

The blanching of the hair is duc to abstraetion of coloured granules of pigment by chromophags, wandering eells, which seize and take them elsewhere ; but this process of whitening does not cause cessation of growth of hair. Sackaroff observed cellular multiplication in the lymphatic ganglia of the old.

Different kinds of wandcring cells devour the pigment of the hair, the osscous lamellæ, the contraetile substancc, the brain, kidney, and livcr-cclls, and pcrhaps the lymphatie eells. After the inroad of the macrophages, thc seereting eells of the liver and kidneys vanish, the macrophagcs arc fixed in their plaec, and hence sclerosis occurs. In a hcalthy young person these macrophages destroy mierobes, but in the agcd, when the cclls of the brain, liver, and kidneys contain fat, they fall a prey. Hair and bonc eells arc incrt, and cannot resist.

In scnile brains thc granulcs of thc ncrvc-cclls are absorbcd by ncurophags. Brain-cclls do not reproduce cven in youth. In like

manner myophags destroy the contractile matter of muscles, and osteoclasts absorb the bony matter.

A similar series of phenomena is seen in diseased conditions, e.g., trichinæ cause multiplication of nuclei and weak and atrophic muscles. Again, disappearance of gland tissue and replacement by connective tissue is seen in alcoholism, plumbism, or infectious malady. Atrophy of the osseous substance is caused by giant-cells in some diseases, e.g., tuberculosis, leprosy, the bacilli of which get into the bones and secrete products which stimulate the osteoclasts to eat the osseous lamellæ.

Cretinism is due to degeneration of the thyroid gland. In the aged both the thyroid and the suprarenals often show cystic degeneration. The normal function of these vascular glands is probably to destroy poisons, and thus their atrophy may have something to do with senile changes. In thyroid patients there are œdema of the skin and loss of hair, but neither of these are usual senile changes. Also in myxœdematous women menstruation is very active, and myxœdematous patients are muscularly developed. Removal of the thyroid is followed by cachexia only in persons under 30.

The degeneration of old age is due to some alteration of some of the more important cells of the body, rendering them liable to destruction by macrophages, which take their place and form fibrous tissue. These cells are those of the skin, mucous membranes, muscles, bones, kidneys, nervous system, and reproductive organs, excepting the testes.

Old people do not lose so much water as younger people do, either by their colder and drier skin or through their kidneys, the normal senile kidney, though resembling the contracted kidney in appearance, not producing polyuria. In fact, the kidneys of the aged undergo a gradual loss of the true secreting cells or renal epithelium, and in this they resemble the small contracted kidney, but the normal functions are not altered in character, though they may be in amount. The urine of the aged is small in amount, has a low percentage of urea, solid residue, and salts, owing to the smaller amount of food taken. If they be healthy, though the kidneys be atrophied, there will be no albuminuria. Glycosuria can be artificially brought about in 80 per cent of aged persons by taking about 140 grams of grape-sugar. Phloridzin, however, does not produce glycosuria so quickly as in adults, because of the less activity of the renal organs of the old. The same amount of chlorides is present in the urine of the old as in that of the young, i.e., if the same quantity be ingested in the food. There is less sulphur owing to less metabolism of proteid.

Cardiac weakness may be supposed to have something to do very often with senile changes, but one should never lose sight of the fact that it is not only often accompanied, but also very often caused, by affections of the blood-vessels, such as atheroma or sclerosis. Demange holds that old age is due to a primary change in the arterial system, which he found even in healthy workhouse inmates. This leads to inadequate nutrition of the body as a whole. Metchnikoff says it is

due to atrophy of the more highly differentiated elements and their replacement by connective tissue.

It is a fact that marked arterial change may be present for many years, and be masked by hypertrophy of the heart, which is almost always enlarged in the aged, and therefore compensates for the arterial defects. Fatty degeneration of the heart is probably produced by a narrowing of the coronary vessels and a consequently insufficient blood-supply to the cardiac muscle. In addition to this direct effect, arteriosclerosis augments the peripheral resistance, and therefore increases the risk of cardiac failure on the one hand and of apoplexy on the other. There are two kinds of arteriosclerosis, viz., (1) Nodular: atheroma of larger arteries. (2) Diffuse: arterio-capillary fibrosis of smaller arteries.

Arteriosclerosis is usually accompanied by hypertrophy of the heart and atrophy of the kidneys. Its chief cause is probably a deficiency of elimination of waste products. Gilbert and Lion produced aortitis by the intravascular injection of bacterial toxines, and the more easily if the aorta had been injured. Later, Josué produced atheroma of the aorta, with hypertrophy of the heart, by prolonged intravascular injection of adrenalin. Similar effects were produced by different observers with tobacco, digitalin, strophanthin, adonidin, hypoxanthin —this last being one of the products of muscular waste, and one of the components of muscle-extract—also by squill and chloride of barium (by Rickett). All the above cause continuous high vascular tension.

The process probably starts by the breaking of the elastic fibres in the arterial wall. In atheroma the fibres are many and aggregated, whilst in arterio-capillary fibrosis they are single and separate. According to Sir Lauder Brunton, from whom we have borrowed on this question, the cause is the lessened movement in the walls due to high tension, and the absence of the motion which naturally occurs in the vessels and occasions a constant interchange of lymph in the walls. Arteries are surrounded by a fibrous sheath enclosing lymph-spaces, wherein is the fluid from which the vascular walls get nutriment. Sustained high pressure leads to degeneration of the vessels, whereby they may rupture, causing apoplexy, which is also favoured by the cardiac hypertrophy also caused by the increased tension. Ultimately cardiac degeneration and failure may supervene. Atrophy of the kidneys is also associated with high tension and with arteriosclerosis.

Arteries may be sclerosed owing to syphilis, or they may have a deposit of calcareous platelets on the inner surface of their walls. M. Josué has caused arterial atheroma in rabbits by injecting adrenalin, and M. Boveri by injecting nicotine. Arterial disease, as is hence obvious, may be produced by microbes or by poisons. Often it is only the smallest traces of lime which are deposited in the walls of sclerosed vessels, and even this small amount is due rather to a degenerated state of the tissues than to the presence of calcium in the food. Hence it is inferred that a calcium-free diet would not help matters much.

It has been said that syphilis and alcoholism together account for 45 per cent of all the cases of arterial sclerosis. Nearly every fifth case is not as yet explicable. Now syphilis is a distinct disease with a definite virus, whilst alcoholism produces a poison arising from fermentation which is caused by microscopic fungi related to pathogenic germs. Metchnikoff suggests that the other cases of arterial sclerosis may be occasioned by poisoning set up by the microbes found in the large intestine. In the other part of the intestinal canal wherein digestion occurs, there are only a few microbes, but in the large intestine 128 million million are added daily. These bacteria constitute one-third part of human fæces. They include bacilli, cocci, and many other kinds of bacteria; some may possibly be slightly useful, but others are pathogenic. It is a mistake to suppose that bacteria are essential for digestion, because mites and other insects can even digest wax and wool, though they have no microbes in their intestines. Likewise the gastric and pancreatic juices of mammals digest various foods, even if the animals be prevented from having any microbes in the intestines.

When the large intestines are penetrated in wounds, the microbes passing into the peritoneal cavity produce a grave and generally fatal illness.

The digestive tube in mammals contains numerous microbes, and many secrete toxins. Guinea-pigs may swallow anthrax bacilli with impunity, unless there be a lesion of the intestinal wall, which will evoke the malady. Again, they may swallow many cc. of tetanus poison, a hundredth part of a drop of which, if injected under the skin, will produce a fatal tetanus. The unharmed intestinal wall is impervious to these and some other poisons, but other poisons are easily absorbed by it, e.g., that of poisonous mushrooms or that of fish, meat, or conserves containing microbes, such as the botulinic bacillus, which secretes a very violent poison. Asiatic cholera owes its symptoms to a toxin elaborated by the vibrio or comma-bacillus in the digestive canal and absorbed by the wall. Some microbic poisons, e.g., phenolic substances, ammonia salts, and others, do not produce antidotes. When the contents stagnate, phenol and indol occur in greater amount in the urine. These substances are probably produced by the bacteria in the intestine, and are absorbed through the intestinal wall into the blood. The principal phenomena of old age seem to be due to the indirect action of the microbes in the intestinal canal.

An old horse or an old dog of, say, from 12 to 15 years, is ugly, moves in an ungainly fashion, has worn teeth, and hair devoid of lustre and white in certain parts. On the other hand a duck, even if 20 years old, is still alert and does not appear to be aged. Parrots and parroquets also retain their activity. A little parroquet from 15 to 19 was very lively, and one from 70 to 75 appears normal and easy in movement.

Birds as a class have a much longer life than mammals. Associated with this are the facts that they have fewer intestinal microbes, and little or no large intestine.

A white mouse has a large number of microbes in the stomach, the upper part of the small intestine has a small quantity, the lower part many, while the cæcum and large intestine have an enormous number. Canaries have very few, the stomach and small intestine being scantily provided, the inferior part of the intestine a little more profusely, but nowhere near so much so as in the mouse. The cæcum, which is a large reservoir for microbes in the mouse, is represented in the canary by two rudimentary culs de sac devoid of germs. The mouse is old after 3 years, and lives scarcely 5 at most, whilst the canary may live 15 or 20.

Cold-blooded vertebrates, like turtles and crocodiles, become very old, and yet show no marked signs of senility. Maintaining only a low temperature as they do, they are inactive and do not need much food. Yet these seeming advantages are not shared by birds, which lead a very active life and keep up a higher temperature than mammals, and still they reach to a greater and more active old age than do the latter, including mankind. The point associated with longevity and absence of senile degeneration that reptiles and birds have in common is that the large intestine is in both small, and the intestinal microbes are few. Wild birds, which have no large intestine, live longer than domesticated birds, which develop it. The microbes that produce putrefaction are the most dangerous, and they are opposed by those which set up the fermentation of sugars and produce lactic acid.

Some healthy men, dogs, and chickens can swallow the vibrio of Asiatic cholera, and destroy it in their interior.

In curdled milk made by a Bulgarian ferment spoken of and placed at our disposal by Prof. Massel, at Geneva, there is a large bacillus which produces much lactic acid. These bacilli may be found many days afterwards, whether introduced as a pure culture or in curdled milk. They stop putrefaction. They are present in the sour milk consumed by the Bulgarians in a region famous for longevity. The lactic acid bacilli present in sour milk vary somewhat, but the best are said to be the so-called Bulgarian bacilli, and it is advisable to add another kind called the paralactic bacilli. The plan is to skim milk and then boil it, then rapidly cool it, and add pure cultures of the lactic microbes and let it ferment for several hours. Sour curdled milk is pleasant in taste, and prevents putrefactive processes in the intestine. It is wise to take from about 400 cc. daily, which contains about 10 grams of lactic acid. The Bulgarian bacilli can be taken in the form of a powder with jam. The activity of both bowels and kidneys is stimulated. This clotted milk should be tried. Moreover, foods, fruits, vegetables, should be cooked and water boiled.

In short, according to Metchnikoff, from whom we have borrowed, intestinal microbes weaken the noble elements and also stimulate the macrophages, which, however, are very useful antagonists to infective microbes, e.g., tubercle bacilli. High tension, then, seems to be due to retention of waste products in the blood, and their action on the vascular walls. Hence we lessen the amount of meat, and give

more water. Early recognition of high tension is important. In order to test it, a bag made to surround an arm is connected with a manometer. Oliver's sphygmomanometer registers the pressure by fluid. Potain's modification of Von Baset's is good. The systolic pressure is counted as that which arrests the pulse, the diastolic being that of maximum oscillation of the index. Sir L. Brunton wrote that with an armlet 12 cm. broad the normal pressure in adults is about 115 mm., and for men of middle age 122 mm. A pressure of over 150 is abnormal, though some apparently healthy may have 180 mm. pressure. However, such are liable to cerebral hæmorrhage or cardiac failure. Meat and strong soups or sauces containing meat-extract should be forbidden, or only allowed in small amount, when the pressure is high, farinaceous food with a little proteid such as milk being all that can be advised. Cholagogues and purgatives, such as blue pill or calomel, may be given once or twice a week, followed by a saline draught in the morning. If there be angina, nitrite of amyl and of isobutyl will quickly stop the pain. Nitroglycerin can be given in divided doses during the day. Nitro-erythrol has a still longer action, and ½ gr. or more three or four times a day keeps the tension moderate and pain in abeyance. Also 20 gr. of nitre with ½ to 2 gr. of nitrite of soda in a large tumbler of water reduces tension and promotes diuresis.

In cold-blooded vertebrata the brain and spinal cord with their cells are capable of being regenerated, but in mammals such regeneration is very rare. It may here be mentioned that some recent observations respecting the value of certain new applications of quick-current electricity are most interesting. It is indeed probable that in this field very much can be found of very great efficacy in regard to various kinds of affections of the blood-vessels and nervous system.

Molluscs, large crustacea, annelids, and many seaweeds and trees may live long and show but little change. Yet senile decay occurs naturally in many plants, and some lower invertebrates, such as protozoa, insects, and some low worms. Though, too, the lower vertebrates, e.g., fishes, amphibia, and reptilia, do not display much senile change, it is seen in birds, and as for mammals, they manifest signs of age more plainly than birds. Dogs lose their glossiness of skin, become indolent and slow of motion, white, perhaps dumb and blind, and their teeth are worn or absent. Cats show similar changes, and are dependent on care and warmth being supplied to them. Old orangs are deficient in teeth, cannot climb, and consequently live on fallen fruits and herbs. Gorillas turn grey. The like is true of man, who loses flesh and vigour as well as teeth and hair. Indeed greyness of hair and decay of teeth are both often displayed rather early in life. The blood is poorer, and respiration less active. The vital capacity of the chest is less, and the temperature is said to be slightly higher. The digestive organs are less vigorous. The walls of the arteries are hard and inelastic, and the veins dilated, so that the circulation of the blood is not effectively performed. The teeth decay and are lost, the cartilages are calcified, the skin is dry, shrivelled and wrinkled,

and its functions, i.e., cutaneous respiration and excretion, are inadequately discharged. The hair turns white and falls off, and both the stature and weight diminish as a rule, unless obesity sets in: muscular movements are less vigorous and precise, the hands may tremble, the head shake, and the gait become tottering. The laryngeal cartilages ossify, the vocal cords become inelastic, and the voice may be pitched in a shrill tone. The involuntary muscles, e.g., of the bladder and rectum, are less able to contract. The media of the eye are dim, the near point of vision is further back, so that the old man becomes far-sighted (presbyopic), and the power of focussing is gone. The tympanum and bones of the ear are so impaired in structure and action as to cause deafness. Even tactile sensibility is lessened. The faculties, emotions, and memory are all weak. Much time is spent in sleep, and the end comes usually from some disease or accident or from natural senile atrophy. The tissues are wasted or infiltrated with fat or earthy matter.

The senile changes seen in old age may be considered as normal, like the cessation of growth in the adult, or as brought about by the slow deterioration of the tissues by poisons, such as those formed in the large intestine by the putrefactive bacteria of the colon. These last can be overcome by the lactic acid bacilli. Dr. C. S. Minot holds the former view, viz., that growth, old age, and death are all normal phases. He shows that over 98 per cent of the original power of growth of a rabbit's ovum at fertilization is gone at the time of birth. Between the 9th and the 15th day of intra-uterine life the average daily increase in a rabbit's weight is 704 per cent, whilst in the next five days, from the 15th to the 20th, it is only 212 per cent. Similarly, between the 3rd and 4th intra-uterine months the human embryo increases in weight 600 per cent, between the 4th and 5th only 200 per cent, and so on, less and less. The percentage increase during the 4th month is the same as that of the whole first year after birth. Cellular changes from fertilization to death are called cytomorphosis, Young tissues have great capacity for growth, i.e., cellular proliferation, which is partially replaced later by growth and differentiation of protoplasm. Senescent cells have more protoplasm and less nucleus. The act of fertilization causes segmentation and relative overgrowth of nuclear matter. The cycle of life has two phases: (1) An early brief one during which the young material is formed; (2) The later long one in which the process of differentiation goes on. Rejuvenescence is increase of nuclear material, senescence is increase and differentiation of protoplasm. The nucleus seems to be the centre of the vital processes of the cell.

Appendix C.

INSOMNIA AND NARCOLEPSY.

A condition of sleeplessness may proceed from many causes—for example, from great fatigue approaching exhaustion, especially if a heavy meal remains undigested. After a severe day's work it is really best to take only light food, with plenty of warm fluid, such as weak tea or coffee, or perhaps soup, gruel, arrowroot, chocolate, or warm milk and water may be better. Also a warm bath before retiring for the night is often very useful, by causing relaxation of the muscles, and lessening arterial pressure. The water should not, however, be too hot, and it is well, at any rate for fairly healthy people, to sponge oneself down with tepid or fairly cold water just before leaving it. This prevents any enervating effect which might otherwise ensue, and should be carried out standing in the hot or rather warm water. The great desideratum is that the cutaneous vessels should react properly to divergent temperatures, since on this power depends the power to resist the tendency to chills and colds which is so general amongst highly civilized and sensitive people. The luxury of our lives nowadays has a tendency to partly lessen the power of resistance to changes of temperature. During the bath the body and limbs should be rubbed with a hand-towel or sponge well soaped, and the duration of the bath should be about ten minutes or so.

If one wakes up during the night, a biscuit or a piece of chocolate may be helpful in inducing sleep, the want of which is sometimes due to digestive disturbance, such as the presence of gas in the stomach or intestines, especially perhaps the colon. These may be stimulated to contract by the eating of a biscuit or the like, and thus the distention be relieved. Insomnia is also frequently occasioned by any excitement or stimulation with drugs, e.g., strychnine, caffeine, theobromine, or by tea, coffee, or tobacco; or it may arise from high arterial tension coupled with chronic renal disease and arteriosclerosis. The cerebral arteries may become rigid in old age, and so retard and lessen sleep. Yet the other extreme of too feeble vasoconstrictor action in anæmia and debility after severe attacks of influenza, typhoid fever, and Graves' disease, whereby the cerebral arteries dilate on lying down, is unfavourable for sleep, so that such subjects fall asleep best when the head and chest are well propped up by pillows. Sleep may be retarded by great cold or heat, light, noise, or by a posture of incomplete relaxation.

Drugs should be used only in case of necessity, and always with the very greatest care. Especially do morphia, hyoscyamine, chloral,

and chloroform need much caution, and the action of drugs like sulphonal, trional, dormiol, veronal, proponal, and heroin also should be most prudently watched.

In the restlessness of pneumonia, pleurisy, and pericarditis, especially if dry cough, or pain, or both, be present, $\frac{1}{6}$ or $\frac{1}{4}$ gr. morphine may be given, but not if there be cyanosis. For sleeplessness in cardiac disease a hypodermic injection of morphine, gr. $\frac{1}{4}$, atropine gr. $\frac{1}{120}$, and strychnine gr. $\frac{1}{50}$ in 6 min. of water may be useful, and half of this dose may often suffice.

If insomnia is coupled with pain, morphine is the best drug ; but if there be only worry and restlessness, bromides, with or without chloral, are advisable; 10 gr. of each of the bromides of potassium, sodium, and ammonium, with 20 min. of both aromatic spirit of ammonia and spirit of chloroform, and 3 min. of diluted hydrocyanic acid with one fluid ounce of peppermint water.

If sleeplessness be coupled with neuralgic pain, 5 to 15 gr. may be given of either antipyrin, or butyl-chloral (chloretone). If it be of neurasthenial kind, 20 gr. of either chloralamide, sulphonal, trional, or tetronal may be given, either in cachet or dissolved in spirit and hot water. Other forms are 8 to 15 gr. of both bromide of potassium and sulphonal or hedonal in cachet. If it be fanciful, lettuce and hops, and sugar of milk, and the hop pillow, may all be used. Both the circulation and the nerve-cells may be so influenced by leucomaines, either those formed in the body or taken in as in tea or coffee, as to cause wakefulness.

Other factors are undue action of the heart through heat, tobacco, alcohol, drugs, or excitement, high tension in gout, or rigidity of the arteries leading to the brain. When the carotids are tense, small doses of KI, together with skilful massage, are useful, as also is ablution of the feet with warm water when they are cold, or warm bathing or sponging the body. If there be acidity of the stomach, a dose of 10 to 30 gr. of $NaHCO_3$ may be given. If the stomach be full, it may be emptied, but if too empty, warm food may be given.

If the patient be febrile and sleepless, the wet pack may be applied, or the skin gently sponged with cold or hot water, after which the imperfectly dried body may be protected by a "cradle" with a sheet over it, and the air thus allowed to act upon it.

Pain is really felt in the cerebrum, but is usually caused by irritation of nerve-ends, nerve-trunk, or spinal cord, though the cause may be some lesion of the central nervous structures themselves. The sensibility to pain varies not only in different persons, but also in the same person. It can be allayed by removing the source and cause of irritation, or by lessening the sensibility of nerves, cord, or cerebral centre. The methods employed are removal or neutralization by drugs of the irritant mental impressions, massage, vibration, and electricity. Sir L. Brunton advises rather the introduction of opium or one of the derivatives in glycerin into the rectum, in preference to giving it on a full stomach. For an aching tooth he advises placing $NaHCO_3$ with

laudanum in the hollow, or rinsing the mouth with soda solution; for hepatic colic, opium followed by inhalation of a little chloroform; for angina pectoris, opium with nitrite of amyl or nitroglycerin; for headache, salicylate of sodium and bromide of potassium. Gelsemium is also useful for headache; but must be given with care. Phenacetin and antipyrin lessen pain by causing a diffusion of impulses in the cord. Chloral, and other chlorine products, such as isopral and chloretone, depress the heart, and may therefore be useful if the blood-pressure be high.

Isopral is fairly prompt in action, if the case be one of mild insomnia, and from 8 to 15 gr. may be given in one dose; but as much as 38 gr. is said to have been tried, though this is really very much too large a dose. It has no power over pain, and must not be used if there be great heart or gastro-intestinal mischief, for even in ordinary cases it may occasion smarting and a feeling of oppression in the abdomen.

The sulphur products, sulphonal, trional, and tetronal, are not as a rule depressing, and this applies still more forcibly to the hypnotics derived from alcohol, such as amylene and paraldehyde. The last, suggested by Dr. Frank M. Pope for topers, is especially both soporific and stimulant, and very useful in cardiac and renal disease, often producing diuresis, and diminishing spasm in asthma and arterio-sclerosis.

Heroin is exceedingly useful, most especially when there is cough and irritation in the respiratory tract. It, like codeine, may be given in $\frac{1}{25}$ gr. doses for cessation of coughing, and is a very valuable drug. In doses of about $\frac{3}{4}$ gr. thrice daily for from two to three days it causes impotence—at any rate, sometimes. It is therefore useful in chordee, and for pains in the special organs, though for some kinds of pains it is not so good as morphine. Sometimes $\frac{1}{6}$ gr. is needed to produce the above-alluded-to anaphrodisiac effect, and this is not a quite safe dose. Lupulin, morphine, and bromides also act in that way. After a time even $\frac{1}{3}$ gr. of heroin will not produce effect, but if omitted for a few days and replaced by lupulin, the power of producing the condition is regained. The drug can be given in pill, powder, or suppository form.

To children or maniacal subjects urethane (which is readily soluble) may be given in from 5 to 15 gr. dose. Sir L. Brunton suggested lactic acid and urethane, and that valerian reduces restlessness. Urethane, like hedonal and veronal, is a compound of urea. Of these veronal is perhaps the best, and in a dose of from 4 to 15 gr. it causes sleep, usually in from half an hour to an hour and a half, and earlier if given in solution, as it can be, on account of being only slightly bitter. If there be great pain, it must be coupled with morphia, and then will aid in producing sleep. It may be given even in gastric ulcer, and usually best in such cases as a suppository. Veronal, even in a dose of 3 gr., is said to be efficient (Huchard), and dormiol is also good. Proponal or dormiol may be given in dose of 7 gr. or more in a gelatin

capsule. Racemic hyoscine, coupled with bromides, is preferred by Professor Cushny.

According to Sir W. Broadbent, a disorder of digestion is the general cause of waking during the night, whilst anxiety prevents the first sleep. If there be gas, even a little warm water may be useful. In cases of high arterial tension, calomel often causes sleep, even before an action of the bowels. Persons who have low arterial tension sometimes cannot sleep in the horizontal posture, as the cerebral vessels cannot contract, so as to reduce the pressure of the circulation in the brain. Waking at about 3 a.m. is sometimes due to emptiness of the stomach, and swallowing even water will be advantageous.

Causes of sleeplessness are diarrhœa, flatulence, delay of digestion caused by fatigue or other factors, want of air, too great heat or cold, noises, light. Dr. W. Hale White advises 10-gr. doses of Dover's powder for sleeplessness in pneumonia, and opium in acute heart-disease, and also suggests chloralamide, heroin, and paraldehyde.

Dr. Huchard suggests that $\frac{1}{10}$ gr. of calomel thrice daily gradually restores sleep, if the arterial tension be high. For low tension, a little strychnine, coupled with about 3 gr. of veronal, or a small dose of dormiol, acts well at times. Cocaine, eucaine, and adrenalin have but a transient effect locally. Orthoform and anæsthesin can only be used in ointment or powder, as they are not soluble. Dr. Bertram Dawson suggests aspirin and trional together for sleeplessness caused by pain.

Narcolepsy is in a sense the opposite of insomnia, for the patient in that condition cannot keep constantly awake. Really, though loosely used, the word should be meant as descriptive of a state in which sudden attacks of brief true and irresistible sleep may occur, beginning with rapidly deepening sleepiness. This is different from a state of continuous sleep, and also from trance and post-convulsive sleep. It is, then, really a condition in which definite and yet brief sleep interrupts a normal state. For a somnolent condition so constant as to be only interrupted by rousing, the term somnosis might be used. The first observer who used the term narcolepsy was Gelineau in reference to a patient of his, aged 38, whose little sleeps, lasting one to five minutes, of which he had about 200 a day, had begun two years previously. In other respects his condition was normal.

Another case described by Gowers was that of a girl of 22, who, since being 16 years old, had peculiar brief sleeps, one to three in number, on successive days, and then an interval of one to two months without them. Each sleep lasted five minutes or longer, and seldom a quarter of an hour. If she at once yielded to the sleepy feeling, it would only last five minutes, but initial struggling not to sleep caused it to last ten or fifteen minutes. Citrate of caffeine caused freedom from the liability for several months. When it was not taken, the sleeps recurred, and afterwards its effect was not so marked. Thus sleeping-sickness is not true narcolepsy. This disease lately destroyed some 200,000 human beings in Uganda, and is

caused by the bite of a fly, the *Glossina palpalis*, after the fly has bitten a crocodile. Special trypanosomes are communicated by this fly to the blood, and afterwards get into the cerebrospinal lymphatics, causing meningitis, which produces a constant state of sleepiness ending in absolute stupor, emaciation, and death. Efforts are now being made to exterminate the crocodiles by finding and destroying their eggs, and it is hoped thus to eradicate the disease. A sleepy and comatose condition is also sometimes associated with the meningitis of influenza, and the authors have known a girl thus affected to sleep for the greater part of three days. Narcolepsy may be so severe in certain states that a person may fall asleep even when standing or walking, and sometimes much disturbance is required to arouse the patient. It is usually merely a transient condition of young women, and probably due to absorption of intestinal toxins owing to constipation. The best rules are to desist from meat, reduce nitrogenous food, regulate the bowels, and take moderate exercise out of doors as soon as practicable.

Appendix D.

FURTHER NOTE REGARDING GERMS.

In order to prove that an infectious disease is due to a particular micro-organism, four conditions laid down by Koch must be established.

1. The micro-organism must be present in the blood or tissues of the man or animal suffering from the disease. The germs may be exclusively present in the tissues, in the blood, or in the lymphatics.

2. The micro-organisms must be taken and cultivated in suitable media outside the body, excluding the possibility of entry of other micro-organisms for several generations, in order to exclude every other material obtained from the animal body.

3. They are then introduced into the body of a healthy susceptible animal to see if it becomes affected with the same disease. This condition is only applicable to diseases which are communicable to animals.

4. The same micro-organisms being found in this animal renders the proof complete.

Diseases of lower animals due to specific microbes are fowl cholera, malignant œdema, pyæmia, septicæmia, various suppurative diseases in rabbits, guinea-pigs, mice, etc., swine fever, cattle plague, foot-and mouth disease, symptomatic anthrax, etc.

The germ-diseases of animals liable to attack human beings are anthrax, tuberculosis, glanders, actinomycosis, erysipelas, tetanus, plague, foot-and-mouth disease, diphtheria, and malignant œdema.

To examine for tubercle-bacilli: (1) Stain sputum with Ziehl's carbol fuchsin for about thirty minutes at about 40° C.; (2) Wash in

water for two seconds; (3) In a $33\frac{1}{3}$ per cent nitric acid aqueous solution for ten seconds; (4) Wash in water; (5) In methyl blue aniline oil for ten minutes; (6) Wash and treat in the usual way.

A film of sputum is spread on the surface of a clean cover-glass, teased out, a droplet of sterile salt solution being added, if required. This film is rapidly dried by holding the eover-glass over a spirit-lamp or gas burner, taking eare not to overheat or ehar. It is simply passed rapidly through the top of the flame about ten times. After drying, steep in a solution of acetic aeid (1 to 3) in water for a few seconds, wash in water, and dry again. Then place the eover-glass over the solution of the dye in a watch-glass. Leave it in for from a few minutes to even twenty-four hours. It is a good plan to first hold the wateh-glass containing the dye over a flame for a minute, until it begins to steam, as it stains then more quickly. After removing the cover-glass, well wash it in warm water, then in distilled water. Then dry again and mount in Canada balsam or Dammar varnish. Finally, seal with a thin layer of Hollis' glue round the edges.

Appendix E.

IMMUNITY.

A MAN or an animal may be apparently insusceptible to a particular diseasc, to the microbes associated with it, or to the toxins produced by them. A power of resistance to the malady is possessed in greater or less degrec, the animal or man having perhaps beeome used to the germs, and capable of neutralizing their activities. This so-called immunity is probably seldom or never complete. If a great quantity of the micro-organisms or of the toxie substance be introduced, the resisting power may be overcomc. The fowl can resist 20 ec. of strong tetanus toxin, but if a greater quantity be injected, tetanic spasms may be caused. Again, the same bird is naturally immune against anthrax, but if the temperature be greatly reduced by making it stand with its feet in ice-cold water, that disease may be induecd. Similarly, in thc case of human beings, the native Indian is supposed to be generally immune against typhoid fevcr, but cases may oeeasionally occur. Also there arc some diseases of which one attack is supposcd to protect against renewal of the malady for some years. Small-pox and typhoid and searlct fevers are said to be so protective against themsclves, but small-pox has oecurred thrice in one patient. Immunity against typhoid occurs aftcr attack, but in some cases, e.g., syphilis, where such protection has been allcged, it is probably only somewhat slight and temporary. In other cases it is non-existent or nearly so, and a human being may havc scvcral discascs, c.g., influenza, bronchitis, and other maladics, vcry many timcs, and one attack may

even predispose to another. An attack of pneumonia, erysipelas, or diphtheria confers merely the briefest protection. Indeed, of some maladies, such as influenza and diphtheria, it may even be said that attacks favour subsequent ones, the power of resistance being actually diminished. So much is this the case in regard to diphtheria, that Dr. D. A. Gresswell cited facts in proof of recrudescence of diphtheria, which would go to show that the specific Klebs-Löffler bacilli perhaps really remain in the throat, and break out again into activity when other conditions favour that occurrence.

The ichneumon and many snakes are not affected by snake-venom, and the scorpion is said to be unaffected by its own poison. Some poisons, that are fatal when injected, are nearly harmless when swallowed. The salivary secretion is said to be partly destructive of snake-venom. Vaccination gives a short protection against small-pox, inoculation with variola itself confers a longer, and the disease obtained by infection in ordinary ways produces a still longer immunity, but, as above said, a person has had the disease three times.

Immunity is not therefore uniform, may be entirely absent, may be only feeble while it lasts, and may be merely temporary. It may be possessed as either a natural or an acquired character of an individual, a species, a race, or class of organisms. In each of these cases, if not natural, as said above, it may have been acquired either in consequence of a previous attack or attacks of the disease, in respect to which the immunity exists, or may have been artificially brought about by the use of serums, vaccines, viruses, toxins, antitoxins, or combinations of them. It is by no means dependent merely on general health or strength, but rests on the complex activities of micro-organisms whose power for harm has been lessened, or by their products, or indirectly and partly by these through the blood of other immune animals.

No doubt it is the case that the phenomena of disease are sometimes the best efforts the system can put forth in order to effect a cure ; but, although we readily admit that for this reason some symptoms should rather be encouraged than restrained, still there can be no doubt that some of them are what may be roughly described as adapted on the kill or cure plan, and, when extreme, unless checked either spontaneously or by outside means, they must certainly do the former of those two alternatives. For instance, the high temperature of some fevers may be the necessary concomitant of the making of an antitoxin, which can destroy the germs, but if prolonged it will of itself alone cause a fatal issue, unless controlled before the product can have time to be produced and set in action.

The febrile and inflammatory processes set up by diseases possess a curative tendency, but are also at the same time in themselves dangerous.

When an animal is immune, it may be because of the presence in the blood or tissues of a substance inimical to the growth of the

microbes connected with that particular disease. However, this certainly is not a complete explanation applicable to all cases, and is indeed the basis of the first of the following six theories of the causation of immunity, for and against each of which something can be said. Probably there is some truth in all of them.

1. *The Exhaustion or Pabulum Theory.*—According to this, the microbes exhaust a necessary element of their growth, but this theory therefore implies that an animal does or may contain several different substances, each of which is a requisite for a special germ. Again, a small quantity of serum of an immune animal will produce in some cases immunity in another animal into which it is injected. This would be a sort of catalytic action, but it is difficult to see how it could lead to the destruction of all or much of the pabulum in the blood. An analogous case is that, so long as a solution contains sugar, saccharomyces will grow and multiply, but, when all the sugar is split up into alcohol and CO_2, an addition of fresh ferment is quite futile. However, if cattle be inoculated with the blood of a guinea-pig dead of anthrax, they become affected with anthrax of a perhaps severe, but not a probably fatal, kind. After recovery, they are protected against a second attack. We know that the bacilli of this disease thrive on almost anything containing a trace of proteids, and hence this immunity cannot be due to the absence of some necessary substance.

2. *The Antidote or Retention Theory.*—This is that the microbes produce some substance or substances which act as a preventive of further growth. If cultures of certain pathogenic microbes are injected, they have a protective effect, but this is not shown in regard to artificial media outside the living body, and therefore it is really increased power of resistance that is caused. The different species of microbes produce different chemical substances, which are inimical to their further growth. This applies to natural immunity, as of pigs to anthrax, and to artificial immunity, e.g., that of cattle which have had an attack of the disease.

3. *Acclimatization Theory.*—This is that in the course of a disease the cells and tissues and fluids acquire a tolerance, so that microbes cannot produce the effect they do at first.

4. *Ehrlich's "Side-Chain" Theory.*—A molecule of normal protoplasm is composed of a simple atom-cell provided with many "side-chains" of atomic groups, or receptors. These combine with the nutriment, and they are of two kinds, viz.: (1) Those capable of combining with molecules of simple constitution; (2) Those capable of breaking up complex molecules by what may be called a ferment-action. Now toxins, according to this theory, possess two kinds of elements: (1) Haptophorous elements, which unite with side-chains of cells; (2) Toxophorous elements, which remain free and cause poisonous effects.

If the dose of toxin be small, the central mother-cell of the protoplasm molecule throws off the receptor and toxin (R + T), which thus becomes

free in the blood, but being neutralized is inert and harmless. New receptors are then continuously produced and set free, some uniting with toxic molecules of the toxins, and some remaining free as "receptors" in the blood. These are in fact the antitoxin molecules, which are normally present in the blood to a certain extent, but are produced in greater quantity when toxin is introduced into it.

5. *The Humoral Theory.*—This is that immunity is due to changes in the serum and other fluids. It is supported by the known bactericidal power of normal blood-serum. There is no doubt that antitoxic or antimicrobic substances or both are developed in the serum, but they are probably the products of cellular action, and though the leucocytes may be mainly concerned, it is probable that the bactericidal substances of normal serum, and the specific substances of antimicrobic sera, are formed, not only by leucocytes, but also by other cells in the various tissues. The origin of antitoxic substances is not known.

6. *The Phagocyte Theory.*—This, like the other five, is probably only partly true, but it affords much help in comprehending at least some of the processes concerned in protection. Prof. Metchnikoff has done good service in bringing it forward, but some of the phenomena he describes may be regarded as the results just as readily as causes of immunity. As so much is involved in the consideration of this theory, we give a fuller account of it in the next section. We may, however, here say that after all it is at bottom just as much a chemical as a biological question that is concerned. Fundamentally all vital processes are in their essence chemical changes, and must in the last instance be so explained. It is obvious that the phagocytes cannot actually manufacture new material. All they contain must be derived from the blood or tissues; for it is difficult to believe that, enclosed as they are in the body, they could possibly obtain anything from the outside air, or water, or ground, or trees, as the case might be of an aquatic, arboreal, terrestrial, aerial, or otherwise living animal.

Wright and Douglas showed that the plasma of the blood is an important factor in phagocytosis. They washed leucocytes free from plasma, made an emulsion of staphylococci, and prepared serum free from corpuscles. If the washed leucocytes and staphylococci were put together, no phagocytosis occurred, until serum was also added. The substance essential they called "opsonin," from *opsono:* "I prepare victuals for." The opsonins are taken in the lymph to the microbes which have gained entry into any part of an animal. With them they combine, thereby rendering the microbes ready for phagocytosis. Leucocytes from normal and those from infected patients are equally efficacious, but serum from an infected person is only half as powerful as that from a healthy one. The number of staphylococci taken up depends on the amount of opsonins present in the serum.

Though, however, this objection is cited, it does not necessarily militate against the theory, but only diminishes its significance, as

showing that, whatever part the phagocytes take, it must at least be secondary to the main one of metabolism of the body at large. If the various processes of digestion and assimilation were not properly performed, the phagocytes might become powerless. However, there is another objection to be urged, for it should be noted that the division of leucocytes into microphages and macrophages does not appear to be an exact one. Doubtless there may be intermediate forms, and here follows a list of the different kinds according to Ehrlich and Lazarus. It seems improbable, if not impossible, to believe that these could be so arranged as to fall into only two groups, each possessing special characteristic functions. These are (1) Lymphocytes which come from lymphatic glands. They have a large central nucleus, and are small, i.e., about as large as the red blood cells, though in children and in lymphatic leukæmia they are double that size, and their nuclei may be irregular or composed of several parts. These lymphocytes altogether constitute 23·5 per cent of the leucocytes. (2) Large mononuclear leucocytes. (3) Transitional cells. (4) Polymorphonuclear neutrophilic leucocytes. (5) Eosinophilic cells. (6) Mast cells.

It may be supposed that this catalogue does not lead one to conclude that the simple division into microphages and macrophages is a very suitable one.

The phagocytic theory is further referred to in the next Appendix, *F*.

Appendix F.

PHAGOCYTOSIS.

Metchnikoff's theory of phagocytosis in its leading outlines appears somewhat as follows :—

The greater number of the simpler organisms seek others for food, at the same time trying to protect themselves from being in their turn destroyed. Sometimes a unicellular vegetable or animal enters into another organism, absorbs its contents, and produces one or more generations, thus destroying its host, a process we call "infection." On its side the attacked organism may interpose a resistant membrane, or may digest the intruder, as is often seen in the plasmodia of the myxomycetes. It is the case that most pathogenic bacteria develop freely in the blood and other fluids of refractory organisms ; but they are actually digested by the phagocytes. The alimentary canal does not do this, for in it, especially in the large intestine, many bacteria and other micro-organisms flourish. The small animals called amœbæ and certain infusoria easily digest bacteria inside their vacuoles by means of a little acid and a ferment called amœbodiastase. Now the bodies of lower and higher animals contain many cells closely resembling amœbæ. These "phagocytes" are found in the epithelial cells of the digestive canal, and also between the body-wall and that

of the same canal, floating in the fluids, or more or less fixed in the interstitial tissue. Most of them circulate in the lymph and blood as colourless corpuscles, and pass into the exudations.

These leucocytes have the power of engulfing and destroying bacteria and matter foreign to the body. The fixed cells also, as well as the fluids of the system, have the same power. In the year 1884 Metchnikoff stated that the leucocytes of a microscopic flea called daphnia envelop and destroy the spores of a fungus which occasions disease in that creature, and he also described the process of phagocytosis in frogs infected by anthrax, and the degeneration of the bacilli in the leucocytes. Generally speaking, if multiplication of leucocytes occurs as a result of disease, the introduction of germs causing migration of leucocytes to the part, the animal has a much better chance of successfully resisting. Further, some substances attract (positive chemiotaxis), and others repel, leucocytes (negative chemiotaxis). It may be that the body-fluids and not the cells destroy the bacteria. The latter theory is called *humoral*, the former cellular. Fresh blood, pericardial fluid, and cell-free serum are all markedly bactericidal, owing to "alexins," but this property is lost by heating up to 55° C., and also by withdrawal of the mineral salts. These protective "alexins" can be precipitated with the proteids from the serum, and, after drying, again dissolved, and still remain potent. It may be that the phagocytes produce the alexins. If a sterilized emulsion of wheat gluten be injected into the pleural cavity of rabbits, an exudation containing many leucocytes, and strongly bactericidal, is obtained. This power is kept after freezing and thawing, and is probably due to "alexins" produced by the leucocytes.

Leucocytes in the invertebrata are small cells having a nucleus, and their protoplasm shows amœboid movement. In the vertebrata the phagocytes or voracious cells absorb into their interior different substances, e.g., microbes, effusions of blood, and so on. There are two categories of these colourless corpuscles, viz. :—

1. *Macrophages*.—These resemble those of the invertebrata in possessing a single, large, unlobulated nucleus, and an amœboid protoplasm. They are present as colourless corpuscles in the blood and lymph and exudations, and as the fixed cells in the connective tissues and in the spleen, lymphatic glands, and bone-marrow. They are sometimes fixed, but at others move about, and especially in the later period of life they are liable to attack the higher elements, e.g., the cells of the brain, liver, and kidney, and other normal tissues, and lead to their atrophy and subsequent replacement by an enlargement of connective tissue. Demange holds that senility is due to decay of the smaller blood-vessels, but this is really, as Dr. Snyder says, only a part of the general process, though it may appear earlier in the capillaries, as he states.

In Great Britain from 1891 to 1900 there were 12,201 deaths from cancer of persons above 75 years old, but as many as 34,822 from heart disease, as well as 39,662 from diseases of the blood-vessels. In

order to complete the list of those dying from circulatory defects, one should add the deaths from apoplexy, paralysis, and senile decay, these being due to affections of the cerebral and other vessels. Senile decay indeed is said to be caused by destruction of the higher elements, especially cerebral and kidney cells, by the macrophages, but it is apparently only the cells of impaired vitality which they attack. This impairment is due to defective blood-supply, and if the brain-cells are well supplied with pure blood, they persist. Hence senile decay is really at least partly caused by alteration of the blood-vessels, though the macrophages actually devour the nerve-cells of the brain and convert the epithelial cells of the retinal tubes into connective tissue. Also being present in the central cylinders of hairs, they devour the pigment. These last are called chromophages, and after abstracting the colouring matter of the hairs and leaving them grey, they pass under the skin or leave the body. It is probable that the macrophages also absorb the framework of bones in the old, leaving them brittle, so that they easily break, fracture of the neck of the femur, for example, occurring in the aged, and sometimes causing death. Also general paralysis of the insane is due sometimes to destruction of the nerve cells by the macrophages. The function of the macrophages is not, however, always detrimental to the organism they inhabit, for it is by them that extravasations of blood are absorbed, and wounds healed. But for them, injuries and hæmorrhages could not be successfully dealt with by animals. In addition to this, they also follow the microphages in case of acute infection or injury. Like amœbæ, they then seize and digest the germs inside their vacuoles, in which there is a weakly acid fluid containing digestive ferments. These macrophages seize animal cells, e.g., blood corpuscles, spermatozoa, etc., germs such as of leprosy, tuberculosis, and actinomycosis, also animal organisms, the amœboid parasites of malaria, Texas fever, and trypanosomata. As a rule, they cannot decisively ingest the bacteria of acute diseases.

2. *Microphages.*—Small, mobile, amœboid cells, which circulate in the blood, lymph, and tissues. Their chief function is to defend the organism against bacteria. They are produced in the marrow of bones, and circulate in the blood, being some of the white corpuscles or leucocytes. They are oval in shape and have a single, several-lobed nucleus, and are therefore easily able to pass through the smaller blood-vessels, for the nucleus splits into several lobes surrounded by protoplasm, each of which passes through the orifices between the endothelial cells of the vessels. Having thus passed through the capillaries and small veins, they accumulate in the exudations that form round microbes. These exudations are very rapidly produced, their result being frequently to arrest infection, for the microphages, being primarily probably attracted by the excretions of the microbes, also absorb and destroy the microbes themselves.

The microphages act more especially in acute diseases, and rarely against animal cells, which, as well as certain bacteria of chronic diseases, they only exceptionally ingest.

Source of Destructive Power of Phagocytes.—The amœbæ digest by means of amœbodiastase, a soluble ferment of the trypsin group. Similarly the colourless corpuscles digest by cytases, which belong to the same group and are otherwise called alexins or complements. These cytases act in a medium which may be freely acid, neutral, or feebly alkaline, and like the amœbodiastase are easily destroyed by heat of 55° C., when contained in fluids, and by that of 58° when in emulsified organs. The macrocytase in the lymphoid organs and serum of the blood acts on animal cells. The microcytase kills and digests many micro-organisms, but has little or no action on animal cells.

Microcytase disintegrates vibrios into granules, and when the microphages are intact, it is within them that it acts. When these are injured, part of the microcytase escapes, and it is then in the plasmas that the destruction occurs. Similarly in blood withdrawn from an animal, the colourless corpuscles allow the ferment to escape into the fluid, where it sets up coagulation of the fibrin.

The serum of rats will destroy the anthrax bacilli, but rats are susceptible to that disease, because in the living rat the phagocytes do not set free their microcytase. Again, the pigeon is not harmed by Pfeiffer's influenza bacilli, although the blood of that bird forms the best culture-medium for that bacillus. Similarly the dog is refractory to anthrax bacilli, although the blood serum of that animal is not at all effective against them.

Fixatives are soluble ferments set free into the blood by the phagocytes which excrete them. These substances fix themselves on to the microbes, which are thereby more easily destroyed by the phagocytes after they have enveloped them. They produce more sensitizing substance, envelop the pathogenic microbes, and destroy them inside their own substance. It has been held by Wright and others that the phagocytes can only destroy such microbes as have been impregnated by "*opsonin*," a soluble substance circulating in the blood, and present in other fluids of the body. It is, however, probable either that the "opsonin" is not essential, or if it be, that it is capable of being supplied by the phagocytes themselves. These fix on to the vegetable or animal micro-organisms or cells, as the case may be, and render them more easily acted upon by the cytases. They resist a higher temperature than 55° C., which destroys the cytases, having to be heated to 65° C., just ten degrees higher, to be killed. They also differ from the cytases in being more specialized, for, whilst the same microcytase can kill all kinds of micro-organisms, and the same macrocytase all kinds of animal cells, each kind of fixative can only fix itself upon a single species of bacterium, or upon a single class of animal cell. Again, the cytases are intracellular, whilst the fixatives are humoral, i.e., present in the fluids, though of cellular origin, being produced by both microphages and macrophages. They are in fact excreted by them into the blood-plasma, and pass with it into fluid exudations, or they may act while still within the phagocytes, when

their action is immediately followed by that of the cytases. Similarly, pepsin, when produced in too great amount for the needs of gastric digestion, is excreted into the blood, and passes into the urine, where it is often present.

Fixatives assist the introduction of the cytases into the cells by what is called a sensibilizing or mordanting action. In some cases of acquired immunity, but not in all, the fixatives are often found in the body-fluids, but there are as well agglutinins, which agglutinate i.e., mass together, and probably thereby render more easily ingested the micro-organisms in animals which have received several injections of micro-organisms. In the same way the fluids of animals injected with blood-corpuscles become agglutinative for them. The agglutinins resist the same temperature as the fixatives, are like them specific in activity, and also like them pass from the cells into the plasmas of the blood, lymph, exudations, and transudations, but they are not the same.

The phagocytes are receptive of chemiotactic sensations, migrate towards centres of disturbance and points attacked, ingest and destroy micro-organisms, and absorb and probably neutralize toxins and other poisons. They fix the micro-organisms by fixatives, and digest them by cytases, and act chemically upon the poisons.

If these phagocytes, on which so much depends, are acted upon by alcohol, or by narcotics such as opium, they are thereby weakened, and made less able to perform their beneficent action. Alcohol diminishes the power of resistance to infectious diseases, especially croupous pneumonia. Even quinine lessens the power except in cases of malaria. Healthy blood-serum, if injected, increases not only their strength, but also their number.

It has also been suggested by Metchnikoff that if human organs, e.g., brain, liver, kidneys, could be obtained fresh almost immediately after death, and were minced and injected into the horse, a serum might be prepared from the blood of that animal, which would strengthen the beneficent action of the phagocytes. It has been found that if cellular elements, e.g., spermatozoa or red blood cells, or cells of liver or kidney, taken from one animal, be injected into an animal of another species several times, the serum of the latter becomes poisonous to those particular cells which have been injected, i.e., it is specifically cytotoxic. However, if such a serum be injected in a small dose, so far from killing or dissolving the special tissue elements, in regard to which it is active, it actually strengthens them. Thus small doses of a serum, which in large amount dissolves the red corpuscles of the human blood, actually increase their number in a patient injected with those small doses. Legal restrictions hamper the injection of emulsions of human organs into animals.

Resistance to micro-organisms does not imply insusceptibility to their toxins, which may produce their bad effects even after the former have been destroyed. Antitoxins normally exist, and are also produced in the body-fluids, and these, too, like the fixatives and

agglutinins, resist heat, are specific in action, and distributed in the plasmas.

Now the red corpuscles acquire immunity with some readiness. The nerve-cells at first become more susceptible, but in the end likewise acquire insusceptibility. A like instance of adaptability is seen in the fact that if the lumbar region of rabbits and guinea-pigs is percussed, paraplegia is produced and lasts for a few hours, but if this be repeated for a few weeks, always at the same level, at length adaptability is engendered, and no paraplegia occurs. Similarly we can become accustomed to all kinds of stimuli, so that their effect is diminished. All organisms, from those which are unicellular to human beings, can gradually be modified so as to withstand unsuitable conditions.

If some quinine be present in the blood, a white cell or leucocyte may be seen engaged in destroying a parasite which has gained access to the blood in a case of malaria. Two little extensions of the white cell, called pseudopodia, slowly encircle the parasite, whose movements become slower and slower, and gradually cease. It is being destroyed by the white cell. All kinds of foreign matters, both organized and unorganized, are found in the white cells, which destroy and digest them. These white cells or phagocytes are really living organisms which devour the bacteria which may gain entrance to the blood or tissues, producing disorders. Unless sufficient quinine be present in the blood of a malarial patient, the leucocytes do not attack the parasites. It has been suggested that immunity is due to certain ferments in the blood. Thousands of lives have been saved by use of anti-diphtheritic serum discovered by Von Behring. According to Metchnikoff, these substances are produced by the leucocytes. The various microbes are by their agency killed or made powerless, and then devoured by white cells in the blood or in the tissues. Many very dangerous germs do not enter the blood. The white cells passing along the adjacent blood-vessels penetrate the walls thereof. A cell may be half an hour passing out of a capillary. Many of these cells then travel to the site of the trouble and ingest the germs which are there. Nearly all infections cause leucocytosis, i.e., a great multiplication of white cells in the blood, so that these may be five times as numerous as before. Should this increase not occur, as may be the case for example in some cases of inflammation of the lungs, the prognosis is grave (Dr. Saleeby).

Two connected events occur after meals. Leucocytosis is the name given to the condition in which there is an increased number of white cells in the blood. It occurs in infectious diseases, inflammation, and also some little time after the ingestion of food in man and several other mammals. At the same time, i.e., after a meal, there is a passage of microbes through the intestinal walls into the circulation. The *Bacillus coli* is one of the chief of these germs. Hence, if it is desired to abstract a pure serum from an animal, the blood should be taken from one that has been made to fast, as then it will be as free as possible

from germs. The increase of the colourless corpuscles occurs in order to rid the body of the microbes and other parasites which enter with food, as they are the chief phagocytic cells.

Many infectious diseases, e.g., malaria, plague, etc., originate from wounds made by certain lower animals, such as arachnids, as a rule. A large number of arthropods give to man and animals the virus of human plague ; malarial, yellow, relapsing, and Texas fevers ; also sleeping sickness. There are also diseases originating from wounds of the intestines caused by entozoa, i.e., mainly intestinal worms. These injure the walls, and microbes enter through the wounds, causing inflammation, and, e.g., appendicitis. Hence vermifuges frequently cure. Probably worms may be concerned in other diseases, perhaps even typhoid fever for example, sometimes. Similarly, anthropoid and lower apes often die of septicæmia caused by the *Bacillus coli*, which possibly enters through the apertures caused by the adherence of worms to the walls of the bowels. Entozoa, and especially nematodes, are often found in cases of appendicitis. They allow entry of germs, and so produce appendicitis, typhoid fever, and perhaps some tumours. Intestinal worms have been found in the midst of tumours of mice—indicating their intestinal origin. It is hence clear that war should be waged against the entozoa, just as against mosquitoes and other microbe-bearing arthropods. In order to prevent their ingress, the food should be carefully selected, washed, and cooked, and all fluids such as water, milk, and so on, boiled, whereby pathogenic bacteria and the ova of parasites can be destroyed.

Cancer of skin is less frequent than formerly, owing to greater cleanliness of the skin, and cleanliness of the interior is just equally requisite.

It is said by Pr. Metchnikoff to be a useful plan to swallow lactic-acid-forming microbes which produce lactic acid in milk, or other beneficent microbes. Soured milk arrests the slow putrefactions in the intestine, for the lactic acid bacteria oppose the growth of the bacteria of putrefaction, and hence these microbes of lactic acid fermentation should be introduced. These lactic bacilli by producing lactic acid prevent the development of butyric acid and putrefactive ferments, which are very deleterious. Cultures of these lactic microbes made in lactose peptone water are useful. Selected lactic ferments may be taken in milk rendered sour by them, or in the form of powder or tabloids. Serum which is a specific against the microbe of "botulism" is known.

Immunity, then, is seen to consist in a power possessed by the colourless cells of digesting the germs of the disease. Obviously, it is impossible to prevent all contact with such pathogenic microbes. For example, it is quite possible for a human being to contain the bacilli of diphtheria, typhoid fever, or the vibriones of cholera, and still not be stricken with the corresponding disease.

During typhoid fever there are developed in the serum : (1) An *agglutinin*, a substance which glues together the bacilli into clumps,

whereby they are destroyed by humoral action. (2) A *sensitizer*, a substance which renders the bacilli more liable to be destroyed in the body.

However, a person may be immune against typhoid, and still not possess any specific properties in his body-fluids, whilst on the other hand the possession of such properties does not ensure immunity, for a case was known in which a large quantity of these agglutinating and sensibilizing substances was present in the serum, when a relapse occurred.

Guinea-pigs into which injections of normal saline solution, urine, serum, etc., had been made, were more able to resist the virus of certain diseases. Heated horse-serum has been successfully injected into the peritoneal or pleural cavities in grave abdominal or pleural operations by Petit. Mickulicz has advocated the subcutaneous injection of a solution of nucleinic acid twelve hours before an operation.

Both these methods increase the action of phagocytes. When the cholera-vibrio is injected below the human skin, it is not very harmful, but in the alimentary canal, not being met by phagocytes, it is very dangerous. In order to lessen the danger of operations involving the peritoneum, it is well to produce an aseptic inflammation by introducing some innocuous substance which attracts many leucocytes. This has been tried to augment an animal's resisting power to experimental injection of germs.

The above remarks mainly apply to the means of protection made use of by organisms against diseases ; but the protective phenomena set to work are very much the same in the case of wounds, injuries, or other local disturbances not sufficiently gravely complicated to come under the heading of diseases, though they may sometimes ultimately produce them.

The processes which make up what is styled inflammation are very instructive in regard to the question of Nature's efforts to protect the system against the bad effects of injuries and other untoward occurrences. Into a wound it is very probable that micro-organisms may be introduced, and if so, they may multiply so rapidly that each may give rise to 16 millions in the course of twenty-four hours, besides producing a large amount of "toxins." The blood supply to the part is augmented, and the part near the wound becomes red, swollen, painful, and tender. These features constitute what is styled "inflammation." Now, the blood-pressure in this region being great, the leucocytes pass through the walls of the blood-vessels in large numbers, and, together with the connective tissue corpuscles, take into their own interior the microbes, which they destroy, unless they themselves perish in the attempt. Many do die, and, when dead, together with the living, are thrown out as "pus" or "matter." If the germs succeed in passing the first entrenchments formed by local inflammation, they are met in the second place by the lymphatic glands, which become enlarged by inflammation, in its turn possibly going on to suppuration. If the wound be in the hand, the glands at the elbow, and afterwards those in the axilla, may become affected, the patient having a

feeling of tenderness in those places. These results, so far from being injurious, are Nature's means of cure, and when it is thereby clear that some noxious materials are being by these means localized, so that they may not get into the general circulation, the surgeon attempts to complete the abstraction of them by incising the tense swelling or opening the abscess, as the case may be.

Now, the peritoneum is very susceptible to the attacks of bacteria, which may gain an entry through a direct wound from the exterior, or a bursting of the wall of the intestine, as for example the appendix coli. As a rule, symptoms of inflammation of the peritoneum at once occur, as if there were a definite purpose to close the breach if possible. In many cases the inflammation occasioned is successful in this closing of the breach and so saving life, but not always. If, however, this does not occur, almost every case of appendicitis may be likely to be fatal (Sir F. Treves.)

Appendix G.

HABITATIONS.

The considerations most important for making habitations are:—

1. The aspect, or exposure to light, wind, and air. The situation should be such that plenty of light is obtained, and this should not be interfered with by trees or other buildings. The structure should, however, be sufficiently sheltered from the north and east, but not so shut in as to impede the free circulation of air round and over the building, for this is necessary to ensure the removal of respiratory and other impurities, such as vapours, and smoke, and foul gases.

2. The site should be dry and non-malarious. It should be moderately elevated, so that there may be a fall for drainage in at least one direction. Thereby a quick and perfect removal of slop waters and sewage may be secured. For this purpose, too, the soil should be porous, e.g., of gravel and sand, and the subsoil permeable. If a house, however, must be built on a retentive soil, then the subsoil must be drained, and dampness obviated by concrete or other impermeable material to a depth of about 6 inches, spread from wall to wall. This will prevent the rising up of vapours through the ground into the house. In any case both the soil and the subsoil under and around the house should be, so far as possible, thoroughly clean and free from sewage or refuse.

3. The ground-water should not be nearer than 8 ft., and not subject to great or sudden variation. This rule is rather frequently not observed, and if the water be pure and be kept from flooding the foundations by frequent pumping when necessary, the dangers are reduced to a minimum, but it is best when possible to observe the rule. Our predecessors, in selecting sites for houses, generally paid regard

to the need for water, and therefore often built on sites near springs. Of course it is most necessary that plenty of pure water for drinking and for cleanliness should be readily available.

4. The construction should be such as to ensure perfect dryness of the foundations, walls, and roof.

It is interesting to observe that in New Guinea, at a distance of forty-five miles from the coast, are the so-called tree-houses, which are built fifty feet high in the tree tops, and are constructed so well as to withstand the strongest gales of wind, so that the thatch is not disturbed. Up above are collected many large stones, which are skilfully dropped on the heads of any raiders who may attempt to cut down the trees.

Appendix H.

MILK AND TUBERCULOSIS.

The following notes were abstracted from a leader in *The Times* of Saturday, Dec. 12th, 1908:—

Professor Koch says that the experiments carried on at the Kaiserliche Gesundheitsamt in Berlin are the only ones which fulfil in every way the actual requirements for coming to sound conclusions as to transmissibility of tuberculosis, those of the British Commission and all other work failing in several respects. According to him, the bovine type of tubercle-bacillus is never found in the lungs of the tuberculous human being, and he seems to deny that human pulmonary tuberculosis is ever the result, or at any rate ordinarily the result, of infection from bovines, but is in nearly all cases directly transmitted from one human being to another.

Now the deaths from tuberculosis in England and Wales during the five years from 1902–6 were 284,308, of which 75,580 were from pulmonary tuberculosis and 125,120 from phthisis not otherwise defined. Probably most of the latter were pulmonary tuberculosis, and, if so, the two groups together represent the total mortality from that disease, which would thus amount to 70·5 per cent, or a little over two-thirds of the total mortality, instead of eleven-twelfths, as we infer was suggested by Koch. Again, the bacillus undoubtedly alters in appearance and also in degree of virulence in correspondence with the environing conditions. (Personally I have noticed that the bacilli become smaller and thinner as well as fewer in convalescing cases in a sanatorium.—G. G.) It has been proved that both bovine and human bacilli produce morbid processes typical of tuberculosis in anthropoid apes, also that bovine bacilli ingested produce similar tubercular changes in the intestinal glands. Similar processes are commonly seen in children who have been fed with tuberculous milk. Also bacilli introduced into the alimentary canal readily gain access to the lungs. Also bovine bacilli, when they have reached the lungs and multiplied

therein, become so changed as to be no longer recognizable as bovine. Koch has failed to infect cattle with human bacilli of the malady, but it is obvious that these may be more capable of resisting human bacilli than human beings are of resisting bovine bacilli. However, the British Commission believed that bovine tuberculosis is a common cause of disease and death in mankind. Koch maintains that the bovine bacillus has never been found in eleven-twelfths of the deaths from tuberculosis. Yet, even if the typical bovine bacilli do not appear in human pulmonary cases, it does not prove they have never been there as the original producers of the malady. Very probably the human environment may alter the characteristics, so that the bacilli look different from bovine bacilli. Still Koch seems to hold that human tuberculosis is exclusively produced by tubercle bacilli of the human type, and if this prove to be really the case, the only inference one can draw is that some of the precautions, which in the opinion of the Commissioners are requisite for the defence of this country from the disease, are not really as necessary as they are said to be.

Chapter XVII.

CONCLUSION.

In the foregoing pages it has been attempted to throw light upon some of the problems concerned with the avoidance of disease, debility, and early death—in short, with the best modes of living a healthy life, and we do not pretend to have done more than to indicate certain lines of work for enquiry and study. It may be objected that for very many such knowledge is practically useless, because it cannot be carried out in any extended sense ; and no doubt this is at least partially true. Still it is more often the case that human beings err through lack of knowledge than through lack of power. For example, the necessity of fresh air and that of cleanliness are frequently not realized, and it is seldom the case that one cannot attain these two requisites. Even if for part of one's time one may, in deference to the desires and regulations of others, have to do with insufficient air, one can generally make up for this at other times. The great point is always to bear in mind the need, and to be constantly on the alert. The same applies to personal cleanliness, and especially in these days in the large towns one has as a rule plenty of opportunities of good and moderately-priced baths. Still greater facilities for bathing in many towns and villages would be advantageous. In Germany one finds the more expensive baths, such as electric-light baths, obtainable even in moderately-sized towns, as well as the ordinary warm baths ; but if the inhabitants of Great Britain could, all over the country, get the latter at a low price (about 6d.), it would be a great gain for the health as well as the cleanliness of the people. No doubt the desire for a constant supply of fresh air and the love of cleanliness are, in the case of many people, innate and instinctive. Unfortunately, however, this does not seem to be always the case, or if it was inborn originally, custom and surroundings and indolence have often eradicated it. Still, where absent, these desires can be evoked by teaching, and if once such habits are learned, they are not likely to be forgotten, simply because they produce a very marked feeling of *bïen être*, i.e., of vigour, both mental and bodily, whereas nothing so depresses as the want of air and cleanliness. Each human being, as a very general rule, wants to feel well and happy, and if it be realized that such and such actions make for health and a delightful existence, the natural consequence is that they will be done, if not too arduous.

Another point in regard to health is that it is seldom or never too late, so long as life remains, to make the best of it, never too late to make one a healthier, stronger, more active creature than one would

be without the extra efforts put forth. However bad things may be, they can very nearly always be much improved, and even if one be fairly healthy and active, there is generally at least some point in which one can be improved. It is most important to note this, because many people are apt to say : " Oh ! I'm about as well and strong as I can expect to be, and it's no good bothering to try to be better than God made me." As a matter of fact, life should rather be looked upon as an incessant struggle, and as needing constant effort to become a better kind of life.

As has been repeatedly pointed out, knowledge is most necessary, and all the more because there are so many who think they know, when they really do not know, what is right and what is wrong. People are very apt to go to extremes. For example, one notes the stuffing of consumptives beyond repletion, and the fasting of other patients, and with the opinion that both procedures are wrong. Again, some eat too much meat and some none at all. It is true that human beings vary, and that such variations in conduct may be in correspondence with different conditions of body necessitating different needs ; but still it is very probable that such extreme points of view and courses are often wrong.

Again, in regard to cities, no doubt some are healthier and better managed from a hygienic point of view than smaller places ; but in cities, too, there are special dangers. One of these is the immense amount of vehicular traffic, whereby crossing the streets becomes perilous. It is true that at important places the police control the traffic in the interests of pedestrians, and such control is now more than ever needful, because the motors have very much augmented the dangers to which the latter are subjected. Indeed, one may say that some further action should be taken by those in authority to lessen the dangers of crossing the streets. Three suggestions may be made :—

1. At every greatly thronged place there should be regular intervals of time when all vehicular traffic should be stopped so as to allow pedestrians five minutes for crossing the road. We might suggest a period of five minutes at the close of each quarter of an hour. Some such course in some places to some extent is already taken, but it should be more stringently carried out, and more frequently.

2. Elevated crossings so high as to be above all vehicles should be erected at all such places as Piccadilly Circus, Regent Circus, Potsdamer Platz (in Berlin).

3. Where they would be more convenient, tunnels for foot-passengers, connecting important centres, should be constructed.

On the whole it is wonderful that some such devices have not been long since more thoroughly carried out ; but now that the additional peril of motor vehicles has been added to the previous dangers of the streets, and it is known that street accidents are far more numerous than they formerly were, something should really be done to make it easier and safer for pedestrians to cross the roadways of cities and large towns.

Even in large and well-conducted cities, such as London and Berlin, much more effectual street-cleansing, both of pavements and roadways, would be advantageous, and as for some of the courts, alleys, passages, back-entrances to theatres, etc., there is very much room for more washing, whereby cleanliness and wholesomeness might be established. This applies in equally great degree to smaller cities and towns.

The importance of hygienic knowledge and practice is very obvious. An illustration of its need may be given from the author of *The Peril and the Preservation of the Home* (De la More Press), Mr. Jacob A. Rüs, who wrote that in New York building laws formerly were not enforced. The Ghetto there was a horrible sight; there were over 300,000 windowless dark rooms, and cellar-homes in which the children had to stay in bed till the tide fell. One quarter of the children born in the worst quarters never lisped the word "mother," one third did not reach their third year, and one half did not reach adult life. Great was the number of the debilitated. Phthisis, diphtheria, typhoid, and other ailments made sad havoc with even the survivors. However, things are better now. The places are subjected to better sanitary conditions, and well lit. Overcrowding is lessened, whilst the mortality is halved, and the tenants are healthier and happier.

This is an example showing what sanitation can accomplish in the way of rendering life more satisfactory ; but here and elsewhere much still remains to be done. This is true of all countries.

The explanation of life has always been, and is, a complicated and difficult problem for mankind. Views regarding human life have varied very much in different ages. By the ancient races, and particularly the Greeks, human beings were very highly esteemed. Admiration for the human form was shown by devotion to sculpture, which was, so to speak, a national art among the Greeks, who thought much of human nature, the human body, and representations of it. They considered that happiness consisted in virtue associated with the due carrying out of all natural actions. The word virtue in this connection probably connoted self-denial, abstention from every kind of excess, and courage—in other words, was practically good conduct in every respect. With the early Christian dualistic view there was a decided depreciation of the body as compared with the soul. Man was considered to be corrupt by his very nature—a conclusion very different from the joyous Grecian view.

In the Middle Ages art fell into decadence lower and lower; but at last the Renaissance brought a kind of return to the Grecian view of the natural life, and the beauty of the human form, and this was further developed in the centuries which followed. A similar re-birth of old ideas affected also science and religion. In the latter sphere this was illustrated by the Lutheran doctrines of the Reformation, which advocated the full development of the natural powers of man. In accordance with this aim the obligatory celibacy of the clergy, advised by the Catholic Church since the fourth century, and enforced

by it since the eleventh up to this day, was discountenanced and abolished by the Reformers.

However, there are still some who so far believe in the benefits of abstention from love as to voluntarily remain single, and, whatever abhorrence may be held by Protestants in regard to enforced celibacy, unquestionably many would agree that self-control is very essential. Indeed, it may be said that there is probably no benefit, no pleasure, no position, no power, which has not some disadvantages inseparably connected therewith, and these last are frequently found to outweigh the seeming desirability. As above said, too, there are fortunately but few strokes of ill-fortune which have not a better side, wherein compensation may be found.

Every benefit has its own peculiar disadvantages, every reverse its good side, and so also in regard to conduct, there must be seen two distinct ways of looking at the subject. The duties of an individual are twofold, viz., firstly, in regard to self, and secondly, with reference to others, and these two classes of claims are in some degree, and occasionally to a great extent, necessarily antagonistic at times, and often do not run on parallel lines. Each unit of a society may be looked at both from the point of view of the unit, and also from the point of view of the society of which he is a member. It is practically similar to the relation of any part to its whole, and of any aggregate to a part of it.

Moreover, as in other questions, the matter is not quite so simple as it at first sight seems, for each unit clearly is a part of numerous aggregates of various and varying dimensions. Thus a human being is, at any rate usually, a member of a family; but can also be regarded as one of a community, as a unit of a part of a nation, as a unit of a whole nation, of a group of nations such as European, of the human race, and even further still, of the group mammalia, the sub-kingdom vertebrata, of the animal kingdom, of terrestrial aggregates, of objects in the Universe. The interests of different aggregates vary, and may often be antagonistic, and hence the code of conduct will also vary, in so far as it is directed to secure the welfare of self, of self and another member or members of a family, of a whole family, of a section of a community, of a community, of part of a nation, of a whole nation, of a group of nations, of the human race, of animals, and so forth. Hence it follows that rules of conduct vary in accordance with the way a human being is regarded, viz., whether as an independent unit, or as a part of one or other section or aggregate of people.

It is difficult to apportion the duties required as between the individual on the one side, and the family, nation, race, and human race on the other. How far should the altruistic feeling of comradeship and generosity be extended—to sections of peoples, to humanity at large, whether civilized or savage? It cannot well be entirely, equally, and universally applicable, unless one is prepared to run the very possible or even probable risk of the ultimate extinction of the white races.

More will be expected from an individual for the family than for the

nation, and more for the nation than for the race, because one is more intimately allied with the former than with the latter in each case. This is a natural outcome of love, of fellow-feeling, and current opinion applauds such discrimination ; but one should recollect that these strong emotions of family-love and of patriotism may at times lead to wrong actions, and actually damage and destroy those whom one wishes specially to cherish and protect. Indeed, praiseworthy as the motives are, the consequences may in either case be the reverse of beneficent, and even sometimes disastrous, as in the case of unwise wars, carried out with every noble aspiration, but ruinous of both nationalities engaged therein, or in the other case where parents, by too great solicitude and care for their children, render them unable to cope with the hard conditions of the world.

Each one should think, What is the ultimate aim ? If we know and realize that life without health is of very little avail, we may expect to see

"all the ruins of distressful times
Repaired with double riches of content."

There are some persons, who, attracted as it were by the piercing brilliancy of a shooting star, which flashes for a time through the heavens, and then sinks for ever into oblivion, prefer the glitter of ephemeral popularity to the sterling worth and value of constant devotion to the cause of truth. Nay, it may be said that many have a tendency to admire the more strikingly beautiful things in nature, and to neglect those which, like hardy but begrimed workmen, are less ornamental but more useful. People have in all ages been more ready to admire rather what has been deemed wonderful and mysterious than the fruits of patient industry and toil. We observe this tendency when we enter upon the domain of medicine, in two ways ; firstly, that in past times unknown spiritual essences were invoked with awe as at once causes and cures for diseases, and also that the ailments of human beings were apt to be considered as, in a much greater measure than is truly the case, distinct from those of animals. In both respects science is progressing, for while the more enlightened of us do not now see that children suck live frogs and toads to death as a supposed remedy for maladies roughly designated thrush and frog, nor extract the so-called tail-worm from the tails of oxen, neither do we look upon the ailments of lower animals as beneath notice, because we know they throw a great light on those to which human beings are liable. Just as human anatomy has been better understood by the knowledge gained from studying the organization of lower forms of life, so also have human pathology and therapeutics been illuminated by study of these sciences as they bear upon animals, and this not merely by finding similarities, but by testing the use of various kinds of protective serums and vaccines, and so bringing about a condition of immunity to particular maladies.

The subject of parasitism is now seen to be of the most urgent importance, since many diseases are now known to be propagated by parasites. So important is it to combat disease, that, even if we

should think that only small successes have as yet been accomplished, which is not, however, really the case, we should by no means remit efforts to advance further in knowledge. The experience already gained will be of great assistance in showing how, and in what direction, future efforts must be directed. Even if we feel very conscious of defects and shortcomings in attainments, it is never too late to start afresh, with renewal of vigour, albeit that our energies may have flagged for a time, and our minds been depressed on account of numerous faults, difficulties, and deficiencies in what information has been obtained. Not only is knowledge necessary, but it must be also well and consistently applied, and that is by no means easy.

In some senses the continuance of the life of an animal or human being may be compared with the maintenance of the sea-worthiness of a ship. In each case there are many dangers likely to be encountered, which may occasion shipwreck in the one case, or ruin to health, and even death, in the other. This applies not only to the graver accidental injuries, and serious diseases and disorders, but also to temporary reverses, griefs, and anxieties of severe nature. In very bad weather, especially if both damp and cold or wind and cold arise, grave illnesses are apt to attack human beings, carrying off many of the young, weak, careless, and old, and more particularly is this true when the change has been both sudden and severe. Quickly as a strong and resilient constitution may adapt itself, it generally taxes the reserve force at first. When, however, a temporary strain or difficulty has been surmounted successfully, one may regain strength apparently almost completely, and go on living for years, just as a ship which has safely passed through a storm can afterwards sail onward as if nothing untoward had occurred. It is, however, really astonishing on what a seemingly small matter either life or seaworthiness may hang. A ship may easily founder on an uncharted rock—perhaps one newly heaved up by an earthquake or a volcanic eruption from the ocean-bed, or it may run into a submerged derelict vessel, and be pierced through its walls or bottom. So also in the case of certain derangements, a sudden sharp strain, as in pneumonia, pleurisy, pericarditis, or severe disease of the heart itself, may cause a snapping of the string which binds a human being to life. Supposing, again, that a man, already the victim of heart-disease, runs quickly to catch a train, he may just so much overstrain his enfeebled organ that death may result. On the other hand, with careful management of his actions, the same man may, and often does, live for a long period. Often, indeed, it is a sudden jar to the system, a storm of harassing anxieties, a huge sea of troubles, an avalanche of germs of disease, or an insurmountable barrier of some kind, that leads up to, and produces, the fatal issue. Hence one ought to exercise the utmost care and patience, not only throughout the whole course of life, but most particularly during times of crisis and stress.

The different kinds of wrong conduct, such as indulgence in tobacco, wine, or opium, are largely a question of habit. Hence one cannot be too

careful not to form any wrong custom; or if such a habit has been already formed, it should be nipped in the bud, and at once abandoned, or at least lessened. No real lasting pleasure can spring from any such practices, which, one and all, bring some defect afterwards.

It may be found that Nature has ways of overcoming almost every difficulty. In regard to temperance, extreme views and too rigidly restrictive regulations may be harmful. More good may accrue from pointing out the great havoc produced by alcohol than by a further curtailment of the free sale of it. No doubt ostensibly good reasons can be brought forward for compulsory restriction or abolition, both in regard to the sale of liquors, and also to other matters which seem to require forcible restraint. Yet legislation of a very stringent kind may frequently defeat its object on account of evoking opposition of equally unyielding nature. Many people can be led by persuasion, who cannot be driven, and all the penalties exacted may probably fail in bringing about the desired result. For a nation to be made virtuous and sober by fear of Act of Parliament penalties is not very practicable.

We have, in regard to such subjects and others of a like nature, as for example, education, examinations, vaccination, vivisection, always held that a marked partisan attitude rather damages than assists the acceptability of one's convictions. It is well, perhaps, to have on many subjects definite views; but wise not to abstain from seeing the other side, and there are always numerous sides to every question presenting any difficulty, as well as especially two opposite sides.

Supposing we could summon, like Aladdin, a genius ready and able to do anything desired, we need not hesitate what to ask. Indeed, if we apply the rules of health, we are far better off than that hero is fabled to have been, for, in the place of such gifts as worldly wealth and grandeur, costly luxuries, a noble and beautiful wife, and the power to be carried swiftly from land to land, we can gain health and length of days.

If such a genius indeed should suddenly stand before us, and ask what services we wished him to confer, we should do well to seek the gifts of wisdom, knowledge, and goodness, together with the boon of living in health and vigour to old age, whereby we may be enabled to do well for the human race.

Within recent times there has been a marked extension of the average duration of human life, and we have in the foregoing pages tried to set forth briefly some of the causes of such prolongation, in order that the indulgent reader may understand what kind of measures ought to be carried out with the view of ensuring still further advances in the same most desirable direction, viz., that of a long, healthy, and happy life for as many as possible of the struggling human race. We ought especially to try to help the weak, particularly children and the aged, and, so far as we can, to protect them from disease and infirmity. To lessen the sufferings, to increase the happiness, of mankind, must be admitted to be one of the worthiest pursuits anyone could wish to accomplish.

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